01202-9 • $8.95 • IN CANADA $9.95 • BANTAM BOOKS

STAR TREK® MAPS

THE NAVIGATIONAL CHARTS OF THE FIVE-YEAR VOYAGE OF THE STARSHIP ENTERPRISE



BASED ON THE AWARD-WINNING TELEVISION SERIES CREATED BY GENE RODDENBERRY

0-553-01202-9

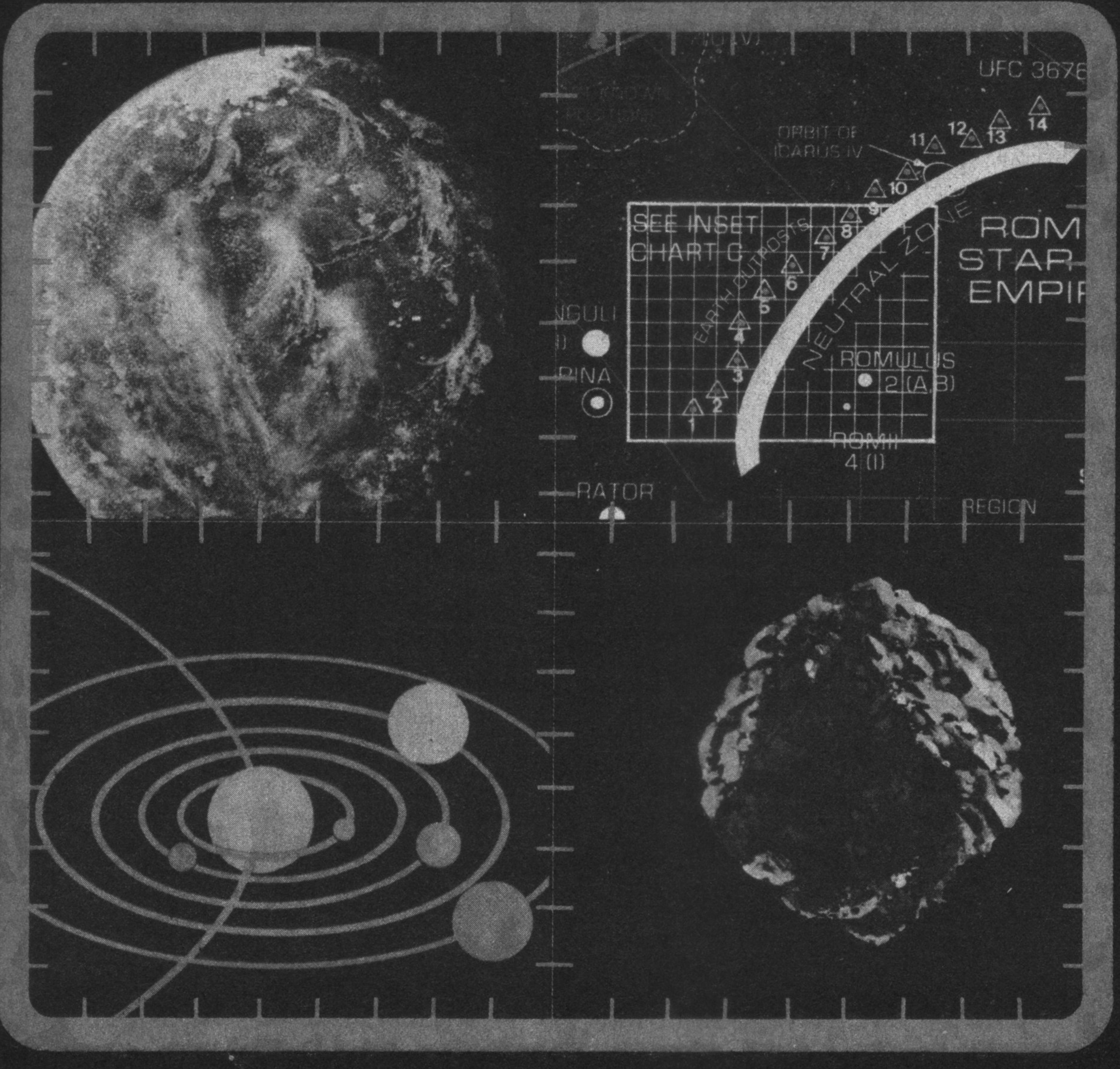
A BANTAM BOOK

TECHNICAL MANUAL | TM: 300149-03

INTRODUCTION TO NAVIGATION

STAR FLEET COMMAND

TECHNICAL PUBLICATIONS SECTION



DEDICATION

The navigation maps and this manual were both a labor of love and an agonizing effort for all involved. The project represents over a year and a half of work above and beyond the call of duty. Through it all, Bantam Books gave us unlimited cooperation. A very special thanks to Bantam Editor Sydny Weinberg, whose support during rough seas (the untimely death of Mike McMaster) never faltered. Special thanks also to the staff at Bantam, who had the foresight to make this project a reality. To all who worked directly on this project, especially Barbara White, Lee Cole, Geoffrey Mandel, Michael Nicastre, and John Upton, my deepest gratitude. To Gene Roddenberry and the cast and crew of Star Trek, thank you for your inspiration and vision.

Jeff Maynard

"All I ask is a tall ship and a star to steer her by . . ."

JOHN MASEFIELD
Sea Fever, 1902

STAR TREK® MAPS
A Bantam Book / August 1980

ISBN 0-553-01202-9

Published simultaneously in the United States and Canada

Bantam Books are published by Bantam Books, Inc. Its trademark, consisting of the words "Bantam Books" and the portrayal of a bantam, is Registered in U.S. Patent and Trademark Office and in other countries. Marca Registrada. Bantam Books, Inc., 666 Fifth Avenue, New York, New York 10103.

PRINTED IN THE UNITED STATES OF AMERICA
0 9 8 7 6 5 4 3 2 1

CONTENTS

Illustrations

Tables

PREFACE

Although originally written as a Star Fleet Academy text, this manual has been substantially revised and updated to serve as an introduction to the basic principles of navigation in space. Some background in navigation or mathematics is necessary, and will enable the interested reader to make use of some of the more advanced navigational techniques that are covered.

The authors of this text have tried to keep the language as concise as possible, and on a level that will be readily understood by a broad cross-section of readers; however, as some of the concepts involved are inherently more difficult than others, we have, where possible, referred to works that will provide a more thorough introduction to these concepts.

After reading this manual, the reader will understand the basic principles involved in interstellar travel, including the use of star charts, navigation and course calculations, and regulations governing the operation of spacecraft. Of course, much more material must be covered before one can become a navigator; but by understanding the concepts presented in this manual you will have taken the first, and most important, step.

A set of four-color star charts have been provided with this manual. Views of the explored galaxy and major star systems are keyed to the navigation information in the following sections. It is recommended that the reader refer to these charts whenever necessary to understand the concepts described below.

CREDITS

Project Design and Coordination	Jeff Maynard
Concept Artist	Michael McMaster
Manual Author and Technical Consultant	John Upton
Copy Control	Geoffrey Mandel
Technical Art	Lee Cole
Typography and Layout	Barbara White (Reilert)
Airbrush Artists	Michael Nicastre
	Rick Sternbach
Proofreading	Phillis Molava
Technical Assistance	Sara Hillman

This manual has been prepared by the Technical Publications Section of Star Fleet Command. It along with the accompanying star charts have been authorized for general release. The data contained is accurate as of the date of publication. Changes will be issued as necessary in the form of Technical Information Bulletins. Current bulletins are available from the Publications Clerk at any Star Fleet installation.

Reader Comments

In order to provide the best possible publications, the Technical Publications Section of Star Fleet Command is interested in receiving whatever comments or criticisms the reader may have regarding this manual. Specifically, we are interested in the following data:

What is this manual being used for? (As a reference, a general introduction, a text, etc.)
Was the material easy to read and understand?
Was the material organized for convenient use?
Specific criticisms regarding what needs to be clarified, added, deleted, any errors, etc.
Any additional comments the reader feels are helpful.

When writing, include the manual name and number (Introduction to Navigation, TM:300149 – 03) so that the comments can be associated with the proper publication. Comments should be sent to:

Star Fleet Command, Technical Publications Section

Thank you for your cooperation.

1.0 INTRODUCTION

This manual is an introductory text designed to give the reader a thorough understanding of the basic principles and techniques of navigation in space. Alone, it will not qualify one as a navigator. There remains a large amount of additional material, covering more sophisticated techniques beyond the scope of this introductory work, that must also be understood.

1.1 HISTORICAL BACKGROUND

The navigation system in use today is the sometimes intentional, sometimes haphazard result of the diverse systems developed by spacefaring civilizations in our galaxy. Current navigational techniques are, for the most part, the result of the natural progression from systems advanced as early as the twentieth century to guide primitive air- and spacecraft from Earth. They have been adopted by many of the other races in the Federation. It is of interest to note that divers navigational systems are still in use within the Federation: for instance, the Vulcan technique of utilizing local polarity of galactic magnetic fields is common in many regions; and the Medusans have developed their own, non-Cartesian methods. This manual, however, addresses itself to the more common, standard techniques. For a discussion of more exotic methods, the reader is directed to works more comprehensive than this one.

When a civilization first embarks on space travel, it is usually concerned only with travel between the planets within its star system. Interplanetary navigation involves tracking the planets within the system and determining the optimum transfer orbits between them. The other stars in the region around the system are used only as "fixed" reference points to determine the location of objects in the system. The word "fixed" is used advisedly, as the stars are in motion; however, their angular movements are insignificant when compared with the objects inside the system.

When the capability for interstellar flight is first achieved by a civilization, new navigational techniques have to be developed to meet the changed requirements. The major requirement of these techniques is to determine precisely the location of the neighboring star systems. Usually, either a spherical or a polar space coordinate system is established, with the civilization's home system as the central reference point. These systems use a series of angles, referenced to different axes, and a distance to locate a star system. Systems of this nature work very well as long as most travel is between the home system and a neighboring one, but they cause great difficulty when travel does not include the home system, as extensive and difficult calculations are required to obtain the relative position of a system.

Later, when other civilizations are contacted, the problem becomes still more complex, since each civilization has developed its own charts, which are incompatible with others. Because each navigation system is centered on a different home system, there is no common basis for locating star systems. These early navigation systems still work while interstellar travel is infrequent. It is possible, although tedious, to work out these navigational anomolies as they arise.

The development of warp drive by Zefram Cochrane in 2050 (Terran) changed the whole concept of space travel. With the ability to make interstellar voyages in weeks, and eventually days, an explosion in interstellar commerce occurred. The critical problem with this expanded trade, from a navigational viewpoint, was that ships could travel farther than was previously possible. The limiting factor in any coordinate system based on angles originating at a single reference point is the accuracy with which those angles can be determined. The greater the distance to a star, the more accurate the angles must be. A small inaccuracy in angular position can cause an error in location that increases with distance from the center of the coordinate system. Eventually, the error can make it difficult or even impossible to locate a distant star system.

When the United Federation of Planets was formed, it was decided to solve this navigation problem by developing a unified navigational system that could be used throughout Federation Space. The rectangular grid system currently in use was chosen, since it allows star systems and other objects to be located precisely, and routes between them to be easily calculated.

1.2 WARP DRIVE

Fundamental to today's interstellar travel has been the development of warp drive. Basically, warp drive consists of the generation of a field about a spacecraft which bends or warps space in the direction of travel. A reaction to the bending propels the ship forward. Since space is being moved relative to itself in a smoothly increasing rate as the center of the field is approached, no neighboring regions exceed the speed of light. However, the total effect on the ship of these incremental speed differences is multi-light velocities. This gradual increase of velocity avoids the speed constraints imposed by the theory of relativity.

The first survey vessels equipped with Cochrane's new space warp drive, such as the S.S. *Bonaventure*, were able to cross interstellar distances in weeks instead of years. A discovery of almost equal magnitude to warp drive was made in the 2160's (Terran), when the Quantum II or "time warp" space drive was perfected. This system is still in use today, and is calibrated on an exponential scale of time warp factors (or simply warp factors). The new time warp drive, so called because of the time dilation effects experienced at warp speeds, enabled the Archon class starships to open vast new frontiers, and extend the boundaries of the Federation by hundreds of parsecs.

The third great breakthrough came in 2243 (Terran), when the "time barrier," warp factor four, was broken by improvements in matter/anti-matter engine design. This made much more energy available, so that more powerful warp field generators could be used. The new propulsion units were quickly installed on the Constitution class starships, and, although capable of speeds up to warp factor eight, they were limited in normal operation to warp factor six by the structural strain caused by the limitations of the ship's compensation field's ability to adequately protect it from the effects of the warp field. Recent discoveries, however, suggest that this limit will soon be exceeded. In theory, warp speeds hundreds of times greater are not impossible for properly designed ships and engines.

1.3 WARP SPEEDS

The classic $W_F^3 \times c = v$ formula (where W_F^3 is the warp factor cubed and c is the speed of light, or about 300,000 kilometers per second) has often been used to determine faster-than-light velocities; but it is obvious that this formula is insufficient if we consider that starships have visited the galactic center,* approximately 30,000 light years distant (a trip which would take thirty years, even at warp factor ten, using this formula).

As Zefram Cochrane pointed out in 2053, actual warp speeds relative to the speed of light may be calculated by multiplying the warp factor cubed by a variable that accounts for the curvature of space in a fourth dimension by the presence of mass; subspace, a continuum in which a vessel under warp drive travels, is not curved in a fourth spatial dimension, and therefore offers a linear "short cut" between points in our galaxy. This variable, called Cochrane's factor and sometimes indicated by the greek letter chi (χ), can be as high as 1,500 in dense dust and gas clouds and as little as 1 in the intergalactic void. It is larger near massive objects such as stars and black holes, as space is curved around such objects to an even greater extent. For practical reasons, warp drive is not used in the vicinity of massive objects, as the disproportionately high warp speeds tend to produce a "slingshot effect," catapulting a starship out of this space-time continuum altogether. Between galaxies, where negligible matter exists, space is not perceptibly curved, and the short cut afforded by Cochrane's factor disappears. Warp speeds attain their "ideal" ($W_F^3 \times c = v$) values, and the transit time to the Andromeda galaxy becomes thousands rather than hundreds of years.

The correct warp factor formula is therefore expressed as $\chi\ W_F^3 \times c = v$, where the value of χ varies with the local density of matter. This variable, somewhat analogous to the winds or ocean currents in sailing, explains why great interstellar distances may sometimes be traversed at greater speeds and in less time than shorter distances. Accordingly, a navigator must take into account any variations in the density of matter along a given route before he is able to estimate the arrival time at his destination.

Table 1.1 shows the corrected values for warp speeds, given an average value for χ of 1292.7238 within Federation space.

Table 1.1 Corrected Warp Speeds

W_F	W_F^3	χW_F^3	Time per parsec hrs min sec
1	1	1,292.7238	22 05 29
2	8	10,341.7904	02 45 41
3	27	34,903.5426	00 49 05
4	64	82,734.3232	00 20 43
5	125	161,590.4750	00 10 36
6	216	279,228.3407	00 06 08
7	343	443,404.2634	00 03 52
8	512	661,874.5856	00 02 35
9	729	942,395.6502	00 01 49
10	1,000	1,292,723.8	00 01 19

*See the log of the U. S. S. *Enterprise*, stardate 1254.4

2.0 THE CHARTS

The set of star charts (A, B, C, D) accompanying this manual will help to familiarize the reader with the standard grid system and with the general makeup of our galaxy, the Milky Way. These charts are similar to standard Star Fleet navigation charts, although somewhat simplified, and many of the minor stars and less-frequented planets have been removed for clarity. The charts are arranged in order of increasing detail, starting with an overview of the galaxy and ending with views of specific planets.

2.1 COORDINATE GEOMETRY

This section contains background material on coordinate geometry, and may be skipped if the reader is already familiar with this subject. It is recommended, however, that this section be read as a "refresher course."

Space is a three-dimensional medium; therefore, a three-dimensional coordinate system is used to locate objects within it. This system is similar to that of analytical geometry, a rectangular system of three axes, perpendicular to each other, as shown in figure 2.1.

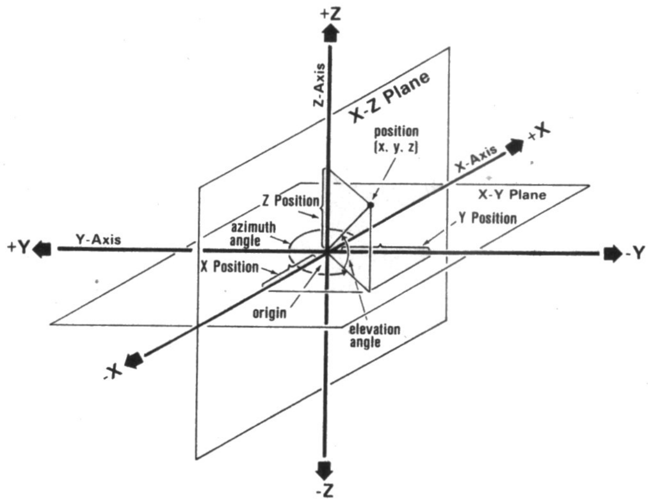


Figure 2.1 Coordinate System

Each axis has been assigned a letter to identify it: *X*, *Y*, or *Z*. The point where all three axes meet is known as the origin (O,O,O), and the axes extend from the origin in both directions, with values given as either positive or negative, depending on the direction. While a single axis may be thought of as a line, any two axes form a plane. Of the three possible planes (*XY*, *XZ*, and *YZ*), only two are used for navigational purposes, the *XY* and the *XZ* planes. The other plane, the *YZ*, is not needed since all of the information contained on it can be found on the other two. All three axes together form a cubic space which may be conveniently divided up into a three-dimensional grid. That is, a series of identical cubes stacked around and on top of each other in three dimensions. Any point in this three-dimensional grid can be located by three coordinates, numbers which correspond to the values of the three axes at that point. The usual order is *X*-axis value, *Y*-axis value, *Z*-axis value, written as (*X*, *Y*, *Z*).

While this rectangular grid system can pinpoint a position in space, it does not provide direction; for a bearing, a spherical system must be used. All angles in this system are expressed either in degrees (°), 1/360th of a circle; or in grads (^{G}), 1/400th of a circle. A bearing consists of two angles, known as elevation and azimuth. Elevation is defined as the angular distance above or below the *XY* plane; it has a value of zero on the plane itself, and reaches a maximum positive value of +90 degrees (+100 grads) at the plus *Z*-axis, and a maximum negative value of -90 degrees (-100 grads) at the minus *Z*-axis. Azimuth is defined as the angular distance on the *XY* plane from the *X*-axis. It is equal to zero at the positive *X*-axis and increases towards the positive *Y*-axis. The two values are usually expressed in the form "(elevation) mark (azimuth)." For example, a bearing of +54 mark 337 degrees.

2.2 LOCATION OF THE FEDERATION

Our galaxy is a spiral star system with a population of about a hundred billion stars, and has a convex lens shape about 30,000 parsecs* in diameter and nearly 4,500 parsecs in thickness. A view of the galaxy from the side is shown in insert #1 on star chart A. The galaxy, because of its bilateral symmetry, can be divided through its horizontal plane into two equal halves, or "hemispheres." To differentiate between the two halves, quasar 3C 68 is used as a reference point for galactic north, and the half nearest to this quasar is known as the Northern Hemisphere. Conversely, the half away from the quasar is called the Southern Hemisphere. Also shown in inset #1 is a pointer to quasar 3C 294, which, along with the galaxy's center of mass, is used to define the *X*-axis of the standard grid system. The small sphere roughly 30,000 light years, or 9,200 parsecs, from the center is the United Federation of Planets.

By tilting the galaxy about 45 degrees downward, so the viewpoint is from above (inset #2), the spiral arms which make up its outer regions become visible. Also shown are two of the nearer star clusters, NGC 1875 and M 13. These globular clusters are primarily composed of population II stars, older stars that contain few heavy metals. The spiral arms of our galaxy, in contrast, are composed mainly of younger, population I stars.

In inset #3, the galaxy is tilted further to give a top view, looking down on the galaxy from the direction of galactic north. This view clearly shows its overall structure, a series of spiral arms originating from the galactic center in a manner typical of spiral galaxies.

Inset #4 is an enlargement of the area explored by the UFP, a section of the Carina-Cygnus arm near the Orion spur. Parts of the neighboring Sagittarius and Perseus arms are visible. The small sphere near the center of the illustration denotes the Federation. The circle marks the outer boundaries of known space. The reader should bear in mind that Federation space is not a perfect sphere, but rather more closely resembles a somewhat dented ball. These "dents" represent regions under the control of other interstellar groups; such as the Klingon and Romulan Empires. Many planetary systems within the limits of Federation space are not members of the UFP, and space around these systems is considered neutral, and, in some cases, hostile.

2.3 THE GRID SYSTEM

Inset #5 shows the arrangement of the axes and the resulting planes which form the three-dimensional grid system discussed in section 2.1. The origin of the grid system is defined by a central navigation beacon that transmits on both normal and subspace frequencies. To define the axes of the grid two very distant quasars are used as references. The extreme distances to the objects eliminates any parallax distortion in the orientation of the axis in the volume of space covered by the grid. Quasar 3C 294 provides the reference direction for the *X*-axis, 3C 68 the direction of the *Z*-axis, and the *Y*-axis is perpendicular to these axes at the origin. The *X*-axis takes on positive values toward the galactic center, and negative values toward its reference quasar (that is, away from the galactic center). Thereafter, normal geometric construction is followed, with the positive direction of the *Y*-axis at 90 degrees to the positive *X*-axis and the negative direction at 270 degrees. The *Z*-axis is positive in the direction of galactic north and negative in the opposite direction.

Federation space is divided into five major sections, as shown in inset #6: four *quadrants*, numbered 1 through 4, and a central sphere called Quadrant 0 (although not properly a quadrant at all). This sphere, 90 parsecs in radius and centered on the central navigation beacon, is surrounded on all sides by the four outer quadrants which, in turn, are bounded by the *XZ* and *YZ* planes. Although quadrant boundaries can be determined from the position of the central beacon and the two axis-defining quasars, a series of beacons have been installed to precisely mark these boundaries. The name quadrant, although historically correct, is now something of a misnomer, since the four outer quadrants are usually split up into northern and southern halves (as in inset #6) and are thus actually "octants." By convention, the northern half of Quandrant 1 is called Quadrant 1 North, the southern half Quadrant 1 South, and so on.

Inset #7 shows an exploded view of the Federation, clearly delineating the quadrant structure and the division into northern and southern halves.

Quadrants are further divided into *sectors*, as seen in inset #8, arranged in a concentric series of "shells" around the central sphere.

The total volume of each sector is about 4,569 cubic parsecs. The volume of all sectors is kept approximately the same by adjusting the size of the defining angles and shell thickness. There are 1,500 sectors in each of the eight outer quadrants, and 668 sectors (arranged in a similar series of concentric shells) in Quadrant 0.

---

*A parsec, the parallax of one second of arc, is the standard unit of distance in interstellar travel, and is equal to 3.26 light-years.

A typical sector from an outermost shell is shown pulled out and enlarged in inset #9. A single sector usually contains a stellar population of less than five hundred stars, low enough to be charted in detail. Each sector is identified by a number which gives the sector's maximum azimuth and elevation angles, as well as its shell number (see figure 2.2). The first two characters of the identification number are the quadrant number and either "N" for north or "S" for south. The third character ranges from "A" to "R," and indicates the greatest elevation angle in the sector. It is marked off in multiples of five degrees (in other words, "A" indicates an elevation of 5°, "B" an elevation of 10°, and so on). The next figure is the shell number, with 1 as the innermost and 10 the outermost shell. The final figure is the local azimuth angle, which is the azimuth angle relative to the quadrant's boundary. It is zero at each boundary, and increases in the same direction as the normal azimuth angle. For example, a sector numbered "4NG-3-50" would be a sector in Quadrant 4 north, and would be in the third shell from the center, with an elevation of between 30 and 40 degrees and an azimuth of between 40 and 50 degrees.

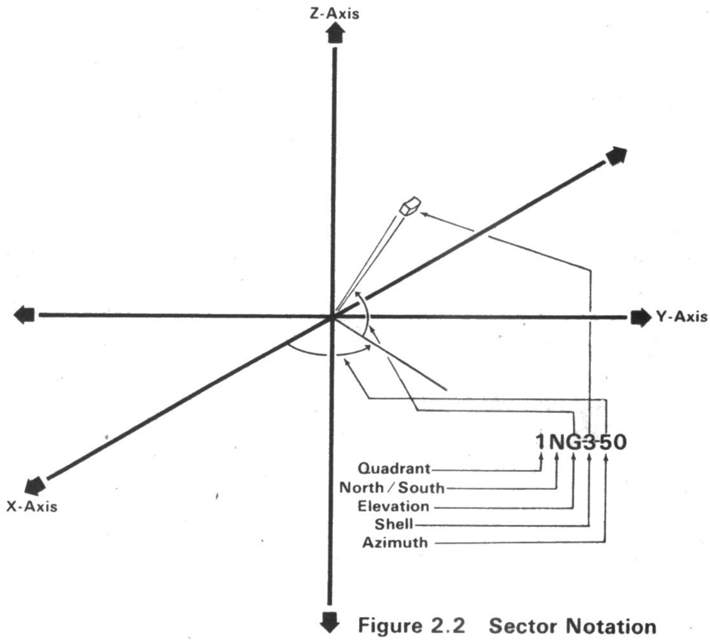


Figure 2.2 Sector Notation

Quadrant 0, the central sphere, is organized somewhat differently than the surrounding quadrants. An overall view is shown in inset #10, indicating some of the more important installations, such as the central navigation beacon, Star Fleet Academy, and major star bases.

2.4 CHART SYMBOLOGY

To understand the astrogation maps, it is necessary to have a working knowledge of the various symbols used. On each chart is a block titled "Map Symbols," which is divided into three sections: symbols describing natural objects, those indicating artificial objects, and a star symbol key.

The size of star symbols on the astrogation maps indicates the absolute magnitude of the system's primary star, the larger the circle, the greater the absolute magnitude, or brightness, of the star. A range of magnitudes from -5 to +9 is shown, and it should be remembered that negative magnitude stars are brighter than positive magnitude stars. This reverse scale is the result of an arbitrary assignment by Terran ancients of bright stars as "first magnitude"; dimmer stars were called second magnitude, third magnitude, and so on. Later, when stars brighter than those of the first magnitude were discovered, they were given negative magnitudes.* The difference in brightness between any two magnitudes is a factor of about 2.5; for example, a third magnitude star is 2.5 times brighter than a fourth magnitude star. To provide some basis for comparison, Rigel is a very bright negative seventh magnitude star, and Sol is a rather dim fifth magnitude star—about 1/40,000 as bright as Rigel. Most stars fall in the range of 0 to +15, and the extreme range for normal stars is −10 to +19.

The color of the star symbols indicates the spectral color of the star, and identifies its spectral class

---

*The system used on old Earth (Sol III) was actually one of *apparent* magnitude. The absolute magnitude of a star is its apparent magnitude at a distance of ten parsecs.

according to the letter system currently in use. Each letter identifies a certain temperature and color, ranging from blue-white (spectral class 0) to red (spectral class M). Most inhabited star systems fall into the range F-G-K, mostly yellow and bright orange stars, but a limited zone habitable under Class M† environmental standards may exist around stars of any spectral color.

Binary (double), trinary (triple), and variable stars are also indicated on the maps. Three special symbols are used to mark so-called stellar corpses: novae, neutron stars, and black holes. These objects should be given a wide berth, as all three broadcast a great deal of lethal radiation.

Several lines of data are given for each star on the maps, following the arrangement shown in the star symbol key. The first line, located above the star, gives its most common name, or if the star is not well-known, the star's number in the United Federation Catalag (UFC number). The next line lists any alternate names for the star, usually the astronomical name based on Earth's (or in some cases, Vulcan's) constellations: e.g., Alpha Centauri, 40 Eridani, b Vela. These astronomical names are set in lower-case type to distinguish them from local or common names, which are given in upper-case. The line located below the star gives the total number of planets in the system, and then the planet numbers of any Class M or other important planets. Additional data on these planets may be found in the appendix to this manual.

Artificial objects—star bases, deep space stations, and outpost monitoring stations—are also identified on the maps by their call signs. Major space lanes, the primary routes between inhabited star systems, are indicated on the first two astrogation maps. The two quadrant maps (charts C and D) outline the patrol routes of Constitution class starships and the communications lanes in the Interstellar Communications Network (ICN). These communications lanes must be avoided, as a passing ship may disrupt transmission and will risk damage by the high-energy beams.

Certain star systems and regions of space have been marked on the charts as danger areas, and should be avoided by all vessels. If further information is required, consult the *Space Operations Handbook* or your navigation computer.

2.5 ASTROGATION MAPS

The large central illustration on chart A is astrogation map #1, an overall view of the UFP from the direction of galactic north and showing the stars projected onto the *XY* plane. A reference grid dividing the Federation into units of ten parsecs square is provided, as is a radial gridwork in units of 10 grads (1/40 of a circle). This map shows the location of most of the inhabited star systems and interesting objects in the Federation, as well as major outposts, buoys, and star bases (it should be noted that some star bases are "eclipsed" by others, and in such cases the base with the highest *Z*-axis coordinate is shown). Regions where the UFP border is in contact with other political units, such as the Klingon and Romulan empires and the Tholian Assembly, are noted, as are some of the civilizations bordering the Federation.

Map #1 gives the coordinates of any star in only two of three directions, the *X* and *Y* coordinates; for the *Z*-axis coordinate, a second map is required, and this is astrogation map #2, located in the center of chart B. It is also a planar projection of the stars in the UFP, but this time onto the X-Z plane. The reference gridwork is the same as in map #1.

On the left side of chart B are two additional maps, #3 and #4. These are enlarged views of the most densely populated region of the Federation, a sphere 45 parsecs in radius and centered on Sol. Historically, this region is the oldest part of the Federation, and contains its five founding star systems. These two maps are keyed to the small circles on astrogation maps #1 and #2.

Chart B also illustrates some of the spacecraft, buoys and other objects commonly encountered in Federation space. Space vessels of all types, classes, and origins, Federation and alien, are illustrated, and familiarization drawings for most of these spacecraft are widely available as well. Interested readers are referred to any standard reference handbook such as Mandel's *Fighting Starships* (TM:305953). Detailed information on the various buoys and navigation beacons is given in section 3.4 and following.

Enlarged maps of a typical quadrant, Quadrant 3 South, have been provided to illustrate the normal patrol route of a Constitution class starship, in this case the U. S. S. *Enterprise* (NCC-1701). A view of this quadrant in the *XY* plane is shown in astrogation map #5 on chart C, and a small orientation drawing shows the overall division into sectors. Sector boundaries and the numbers of representative sectors have been included, along with the usual locator grid in units of 10 parsecs. As with the main maps, an additional view, astrogation map #6 on chart D, is needed to provide *Z*-axis coordinates. The normal patrol route of the *Enterprise* is indicated on map #5, although the actual route of the *Enterprise*'s travels over any length of time is likely to be very different; special missions and emergencies frequently make it necessary for starships to divert from their patrol routes, and even to leave their assigned quadrants altogether. Also shown on these maps are some of the less-frequented star systems in this quadrant.

†Not to be confused with spectral class M; see Chart B

The lower part of chart C contains maps of regions that are not part of the UFP: the Romulan Neutral Zone and the home systems of the Klingon Empire. These maps are keyed to the small rectangles on astrogation map #1.

Many different types of star systems are contained within the borders of the UFP, and to give the reader some idea of this variety, several noteworthy systems are illustrated on charts C and D. The heavily populated Rigel system, a binary system composed of two blue-white giants, is of interest in that it supports so many inhabitable planets—most systems have only one or two planets habitable under Class M requirements.

On the left side of chart D are illustrated some of the more important or interesting planets in and near the UFP. All the planets are illustrated in approximately the same scale, and if the planet has any natural satellites they are shown to scale.

3.0 NAVIGATION

Navigation can be defined as the technique of determining a route from one place to another. When this idea is applied to interstellar travel, however, it becomes somewhat more complex. The large number of stellar systems, the unusual conditions that can be encountered in space, and the traffic density in some areas, make interstellar travel much more difficult than it would first appear. There are some mathematics involved; while not complicated, they must be precise. Even a small error, with the immensities involved in interstellar navigation, can result in a major problem. Most of the required calculations can be done by the navigation computer found on any starship. But a navigator is more than someone who just keys data into a computer. A navigator must have a "feel" for what is being done. A computer can only process data given to it. Navigation requires in addition to this, an understanding of the situation. Sometimes the obvious choice is not the best one, and only someone with the proper training can make the correct decision. The rest of this section gives background in the basic techniques needed for interstellar navigation.

3.1 NAVIGATION COMPUTER SYSTEM

Every interstellar spacecraft is equipped with a navigation computer system. The exact configuration of the system varies from ship to ship, depending upon type of spacecraft and the mission assigned to it. The general organization of a basic navigation system is shown with solid lines in figure 3.1 below. It consists of two major elements: a computer subsystem and several peripheral or external devices attached to it. The computer subsystem is composed of three parts. The central processing unit performs the calculations and logical operations needed for navigation as directed by its programming. The memory bank holds the programs for the processing unit, coded versions of the star charts, tables listing reference data on planetary systems, and other necessary information. An input/output controller is used to transfer data between the computer and the peripheral devices. This unit transfers large blocks of data between the memory bank and each peripheral, independent of the operation of the central processor. It increases the efficiency of the computer by making it unnecessary for the central processor to take time to control each individual data transfer. With this unit data transfers and processing can operate concurrently.

Some peripheral devices provide the computer with information from the external environment. The inertial reference platform provides a continuous attitude reference aligned toward galactic north. No matter what the orientation of the spacecraft, the platform will continue to point to galactic north. Attached to the platform are a group of accelerometers, which measure the ship accelerations. The computer uses the platform for orientation and the acceleration data for velocity and, in turn, position determination. The time standard is an extremely accurate clock, also known as the ship's chronometer. It is used as a time reference when calculating the time delay in signals reaching the ship. The subspace radio, besides being used to pick up subspace beacon signals, is also used for communications. It contains a direction finder which automatically determines the direction of an incoming signal relative to the navigational coordinate system. The electromagnetic, or conventional, radio provides the same functions: signal location and communications, but in this case using signals in the electromagnetic spectrum. The sighting telescope is used to locate reference stars, and contains a spectroscope for accurate stellar identification. The data terminal gives the navigator a means of control and interaction with the system, using a keyboard and various visual displays. On some ships the terminal will also respond to voice commands, and reply with synthesized speech. The data links transfer data between the navigation computer and two other parts of the ship's electronic equipment: the helm controls and the central, or library, computer. The link to the helm is used for loading a course into the autopilot. The library link is used to obtain additional data for the navigation computer or to log course information into a permanent record.

The navigation computer system described above is adequate for most spacecraft, though some of the larger ships, such as the Constitution class starships, have a more extensive system. This is necessary

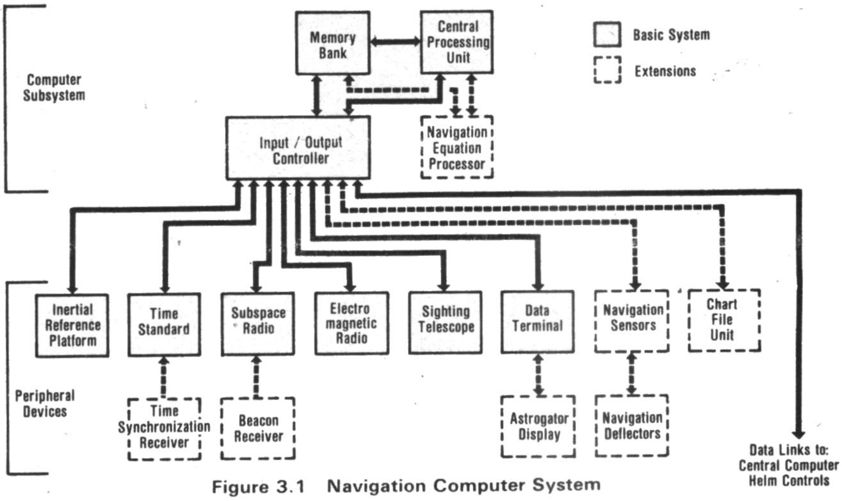


Figure 3.1 Navigation Computer System

because the starships operate in the more distant regions of Federation Space, and more precise calculations are necessary to determine the location of the ship. In addition, these ships continuously chart the regions they travel through. The computer system is enlarged by the addition of equipment, as shown by the broken lines in figure 3.1, to handle this increased data rate. The major addition to the computer subsystem is a navigation equation processor. The function of this specialized unit is to quickly solve navigation equations. It contains special logic hardware designed solely to process navigation equations. In this configuration the central processor merely tells the equation processor what equations are to be solved, where the data to be used are located in the memory bank, and where in the bank to place the results. The equations processor, acting independently, then solves the equations. When it is finished, it informs the central processor that the results are ready to be used. This unit relieves the central processor of practically all mathematical calculations. The primary function of the central processor then becomes overall system control: that is, it coordinates the operation of the equation processor, the input/output controller, and the peripheral devices, so that data is collected, processed, and recorded as required.

The larger computer systems also contain additional peripheral devices. The farther a ship travels away from the center of the UFP, the more critical time standard stability becomes. Any change in the frequency of the standard will cause an error in position determination that increases with distance. To insure the accuracy of the time standard a time-synchronization receiver is installed. This unit receives a fixed-frequency signal transmitted by the central beacon array. Any difference between this frequency and one produced by the time standard generates an error signal which the time standard uses to correct its internal operating frequency. Since a large spacecraft must maintain a continuous check on its position, special beacon receivers are added to the subspace radio. These receivers continually monitor the seven major marker beacons, and any other beacons selected by the navigator. Data received from the beacons, and their positions relative to the ship, are sent to the computer. A large amount of data must be gathered on any object near the ship to accurately chart the region around the spacecraft. An array of high-resolution navigation sensors is employed to collect this information. They are divided into two groups: active sensors, which send out a signal and then examine the response; and passive sensors, which only receive data. Attached to the sensors are the navigation deflectors, a series of cone-shaped force fields with their common apex pointing in the direction of the ship's flight. The function of the deflectors is to move small objects, mostly interstellar gas and dust, out of the path of the ship. Smaller ships have a similar arrangement of sensors and deflectors, which are used only for collision avoidance. Since their purpose is to sound a warning or trigger evasive action if something is too close to the ship, they are of a lower resolution than those of a large ship.

A Constitution class starship may find itself in any part of Federation space. This requires the ship to have very detailed charts of all of known space. A memoray bank large enough to contain all of this information at one time with quick access would be difficult to construct. Fortunately, not all of the material must be instantly available. The computer needs detailed information only on the sector the ship is in, and the twenty-six sectors surrounding it. The remaining information can be stored elsewhere and transferred into the memory bank as needed. This bulk storage is provided by the chart file unit. It holds the remainder of the star charts not currently needed by the computer. It also stores new chart data collected by the computer during the voyage of the ship.

Large spacecraft frequently encounter difficult navigation problems. A special visual display known as an astrogator is used to accurately present the large amount of data needed for the navigator to understand and solve these problems. Located between the helmsman and navigator stations on the helm

of Constitution class starships, this 60-centimeter-square display provides a continuous presentation of the region around the ship. The view is normally oriented to show the relative *XY* plane through which the ship is traveling. The direction of travel is at the top of the display screen, and the ship is located in the center. Various manual controls allow changing the scale and orientation of the display. Different types of information can be selected for display. A manually controlled marker, or cursor, can be positioned anywhere on the display screen. It is used to select specific points on the display for more detailed examination. It can also be used to inform the computer of the course to be followed. Different courses can thus be plotted and the best one selected.

In normal operation the computer constantly receives data from the peripheral devices, processes it, and uses the results to produce the course track and present position of the ship. The navigator can at any time use the terminal to gain access to data in the computer. This includes the present position of the ship, its course, the star charts, or any other information in the memory bank of the system. The system has two major functions; determining the position of the ship, and plotting courses. Both of these functions are described in general terms below.

3.2 POSITION DETERMINATION

The best way to find your position in space is to ask your navigation computer. The computer will give you your location coordinates to six decimal places. However, your computer may not always be available. Even with a triply redundant system, failures can occur. The inertial reference platform may "drift" over a length of time. Minor inaccuracies may accumulate to the point that its orientation to galactic north becomes unreliable. It cannot be used in determining the orientation of the ship unless it is recalibrated. Under these conditions the position of a spacecraft can still be determined. The complexity of the technique needed depends on how much of the computer system is available. Of course, the more work that can be done by the computer, the easier it will be for the navigator.

The most accurate method of determining the position of a spacecraft if the inertial reference platform is unavailable is to use the subspace beacon system. This system consists of the central beacon, the beacons defining the quadrant boundaries, and the north and south beacons. Each beacon continually transmits, on a specific frequency, its call sign followed by a code indicating the exact time the transmission was made. Since the speed of propagation of a signal through subspace is proportional to the power of the transmitter, and the power is known, the speed of the signal can be determined. By computing the time difference between when the signal was transmitted and the present time on the ship, the delay, and in turn, the distance from the transmitter, can be calculated. The first step in determining the position of the ship is to calculate the distance between the ship and all seven beacons. The two closest quadrant boundary beacons mark the edges of the quadrant wherein the ship is located. Which sectors of the quadrant the ship is in depends upon whether the north or south beacon is closer. If the north beacon is closer, the ship is in the northern sectors. Likewise, if the south beacon is closer, the ship is in the southern sectors. On rare occasions, when the distance to these two beacons is the same, the ship is on the *XY* plane. It should be remembered that if the distance to the central beacon is less than 90 parsecs the ship is inside the central sphere. This does not change the method of determining the position of the ship; it just means that the ship will not be in one of the quadrants.

In addition to the distances (*a*, *b*, *c*, *r*), the angles between the central beacon and the three closest beacons (*A*, *B*, *C*) are needed. This arrangement is shown in figure 3.2

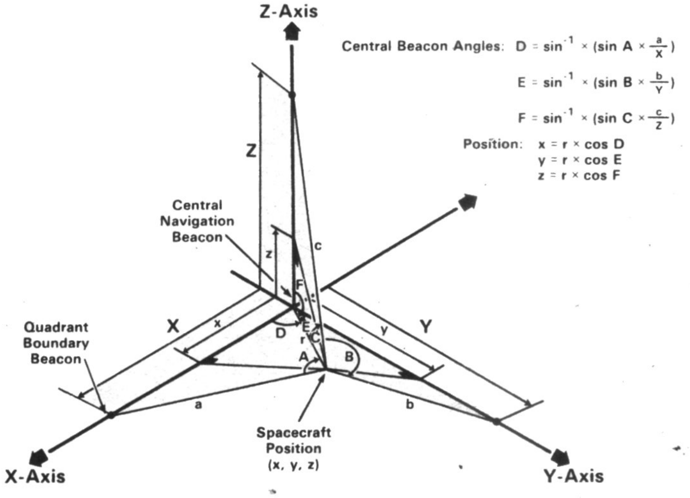


Figure 3.2 Beacon Position Location

The three values calculated using the equations in the above figure are absolute values. They do not have the positive or negative direction needed to locate a ship in the proper region of the grid. The directions are found by noting which beacons were used in the calculations. The *X* and *Y* values take on the same direction as the quadrant boundary beacons used to determine them. The *Z*-axis is positive if the North beacon was used. Conversely, the *Z*-axis is negative if the South beacon was closer. This information is summarized in table 3.1.

Table 3.1 Region Determination

Quadrant Boundary Beacons		Z-axis Beacon	Region	X Value	Y Value	Z Value
+X	+Y	North	Quadrant 1, Northern Sectors	positive	positive	positive
+X	+Y	South	Quadrant 1, Southern Sectors	positive	positive	negative
−X	+Y	North	Quadrant 2, Northern Sectors	negative	positive	positive
−X	+Y	South	Quadrant 2, Southern Sectors	negative	positive	negative
−X	−Y	North	Quadrant 3, Northern Sectors	negative	negative	positive
−X	−Y	South	Quadrant 3, Southern Sectors	negative	negative	negative
+X	−Y	North	Quadrant 4, Northern Sectors	positive	negative	positive
+X	−Y	South	Quadrant 4, Southern Sectors	positive	negative	negative

Another method of determining the position of the ship can be used, if it is not possible for the spacecraft to receive subspace signals. This method uses the various pulsars located in Federation space. Each pulsar, which is actually a rapidly rotating neutron star, has a unique pulse frequency which slowly decreases over time as the rotation of the star slows down. By determining the frequency of the signal received from the pulsar it is possible to identify it. Since the frequency change is linear over time, the present frequency of the pulsar can be calculated. The difference between the two frequencies tells when the signal left the pulsar and in turn the distance from the ship to the pulsar, since the signal travels at the speed of light. This distance defines the radius of a sphere with the pulsar at the center and the spacecraft located somewhere on the surface. If three widely separated pulsars are selected and the distances to them are determined, a series of intersecting spheres is produced. This arrangement is shown in figure 3.3. There is only one point where all three spheres intersect, the location of the spacecraft. To find this point the set of equations shown in figure 3.3 must be solved simultaneously. That is, a set of values for x, y, and x must be found that, when inserted into all three equations at the same time, causes them to balance.

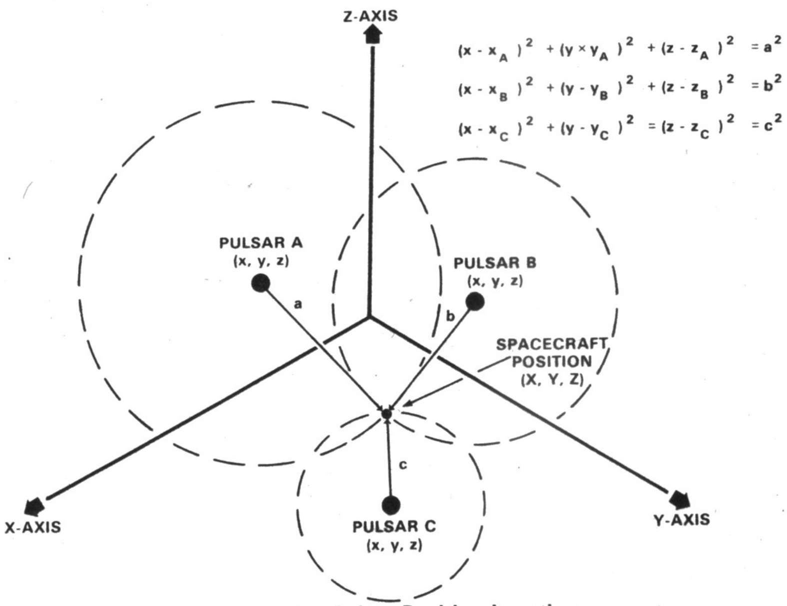


Figure 3.3 Pulsar Position Location

If all that is available to the navigator is the sighting telescope, the position of the ship can still be determined. This requires the accurate identification by their spectra of several widely spaced stars and calculating the angles between them. The mathematics needed to convert these sightings into a position goes beyond the scope of this introductory manual. A copy of a more advanced text, such as *Navigation Techniques* (TM:300420), should be obtained if the reader is interested in this technique.

3.3 COURSE CALCULATIONS

Once you have determined the coordinates of your present position and found those of your destination from either your computer or a chart, it is possible to plot a course between these two points. A course is defined by two angles, azimuth and elevation. These angles can be referred to in either absolute or relative terms. If they are given on an absolute basis, the angles are based on the stationary grid system with a zero azimuth angle pointing along the positive *X*-axis and a zero elevation angle in the *XY* plane. If the angles are expressed on a relative basis, the present orientation of the ship is used as the zero reference. It is standard for course angles to be given in absolute terms, and a standard terminology has been developed to prevent any confusion over which version is being used. The phrase "come to course" is used when the course angles are given in absolute terms. If the word "steer" is used instead, the angles are relative. For example, "Come to course 37 mark 136" would mean to place the ship on a course with an elevation angle of 37 degrees and an azimuth angle of 136 degrees absolute.

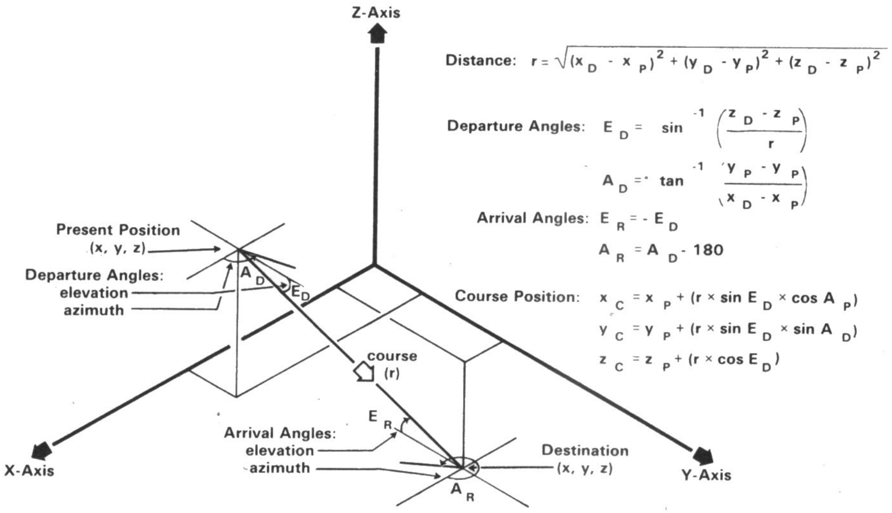


Figure 3.4 Course Angles

The absolute course angles are found by using the first three equations in figure 3.4. The distance to the destination (*r*) is calculated first. It is the square root of the sum of the squares of the differences in position in each of the three axes. Next, the elevation angle (*E*) and the azimuth angle (*A*) are determined. The elevation angle is the inverse sine of the difference in *Z*-axis positions divided by the distance to the destination. The azimuth angle is the inverse tangent of the difference in *Y*-axis position divided by the difference in *X*-axis positions. These two angles become the departure angles or bearing—the direction in which the ship heads for its destination. (In most cases the arrival angle will be the same as the departure angle relative to the galactic coordinate system.) The navigator should know two other angles, the arrival angles or bearing—these are the absolute angles at which the ship will approach its destination. They are given by the last two equations in the first group on figure 3.4. To find the position of the ship at any point along its course, the second set of equations are used. They convert the departure bearing and the distance travelled into X, Y, and Z coordinates.

The course found using the equations above will take you on a straight line to your destination; however, with the large number of objects in Federation space, that course may not be the safest one. It might take you through such unpleasant places as a black hole, a supernova, or the Klingon Empire. Thus, to avoid such mishaps, once the course has been plotted on the appropriate astrogation map, its track must be examined for any unusual objects. If the track intersects such an object there is the possibility of a conflict. It is only a possibility since the course could be in front or behind the object, and this may not be apparent from the chart. Some calculations are required to determine if there actually is a conflict. The value of one of the axes at the point where your course intersects the object is used as a starting point. With this value the distance along the course and in turn the value of the other two axes can be found. A problem arises only if the value for all three axes match those of the object. The calculations are similar, though a little more complex if the object to be avoided is a line, such as a space lane, or a communications lane since the distance, and the axis values for both, must be calculated. Normally, this determination is done automatically by the navigation computer. It will flash a warning if it detects any conflicts.

If your original course does run into such a conflict, a new route must be chosen. This is done by

establishing an intermediate point, known as a "waypoint", at some distance from the problem area. Then course segments, or "legs", are plotted from your present position to the waypoint, and from the waypoint to the destination. Each segment is treated independently, with its own distance, elevation, and azimuth angles.

3.4 AIDS

The UFP has established various aids to reduce the hazards of traveling in interstellar space. The most common are the beacons. These are essentially high-powered, omnidirectional transmitters, which send out signals on both normal and subspace frequencies. Each beacon has an assigned call sign, or identification signal, that it transmits along with additional information that varies depending upon its function.

Position reference beacons are used to define points in Federation Space for navigational purposes, and include three major types: the primary boundary beacons in the subspace beacon system (described in section 2.3), the space lane beacons located at the endpoints of each major lane segment, and those used in the approach position reference system. This latter group is used as a continuous location reference by spacecraft maneuvering in star systems with a high traffic density.

Area marker beacons are used in areas of space that require special identification, and they transmit an identification code and a description of the area they are marking. The difference between the various types of marker beacons is in the strength of their transmission: beacons marking hazards to navigation have an omnidirectional signal pattern and a moderate signal strength, while those marking dangerous regions, such as the area around a nova, have a similar but much stronger signal. Marker beacons are also used to identify individual star systems; it is much easier to home in on a beacon than to locate an object by its grid coordinates. Still another kind of beacon is carried aboard all spacecraft, and transmits the registration number of the ship at regular intervals. This beacon can be used by shuttlecraft and other small vessels to home in on a mother ship, and can be converted into a disaster beacon when necessary, sending out high-power signals designed to attract attention.

The space lanes are another aid set up to assist interstellar travel, connecting most major star systems with other locations within the Federation. Space lanes may not always provide the shortest route, but, because they are free of any obstructions, higher speeds and shorter travel times are possible. A typical segment of a space lane is shown in figure 3.5—each lane segment is numbered, and its endpoints defined by two reference beacons. Each beacon, in addition to its own omnidirectional identification signal, transmits in the direction of the other beacon a directional beam that defines the lane, and an additional directional beam is generated for every other lane segment that uses the beacon.

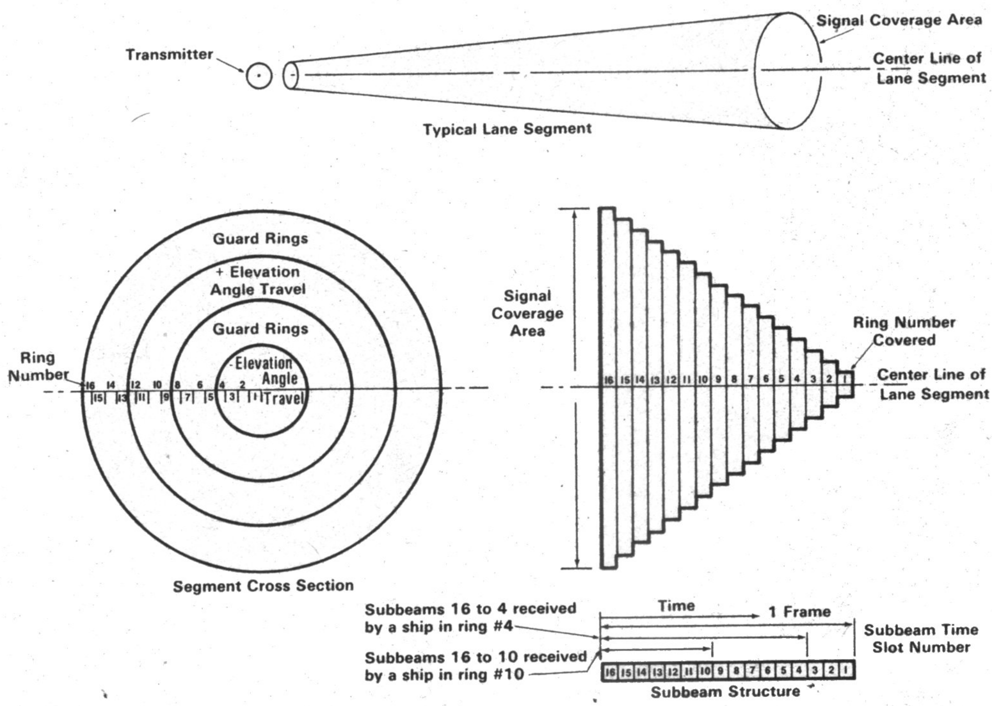


Figure 3.5 Space Lane Segment

To prevent head-on collisions, which at multi-warp speeds can be quite devastating, traffic within a space lane is separated according to direction. Ships traveling on a course with a negative elevation angle use the centermost five rings, and the next four rings outward are reserved for drift correction. The next four rings are for ships on courses with positive elevation angles, and the three outermost rings are again used for drift correction. In the rare instances when the space lane has an elevation angle of zero, a notation is made on the charts to indicate which rings are used for what direction.

3.5 SUPPORT FACILITIES

Throughout Federation Space, a series of support facilities have been established, including star bases, deep space stations, and outpost monitoring stations. Star bases are major military resupply and refitting installations. They contain the supplies, equipment, and personnel needed to repair and outfit any Star Fleet vessel. In addition, they provide training and recreation areas, administrative offices for local command posts, and living quarters for station personnel. Star bases are nearly always located on the surface of a planet because of the size of the facilities and the large amounts of raw materials needed for their operation. They are placed as closely as possible to central points in the Federation grid structure. Currently, there are twenty-eight star bases in Federation Space, and new bases are being constructed at the rate of about two per year.

Deep space stations are major civilian repair, resupply, and refueling facilities, and are also used by military spacecraft when the elaborate facilities of a star base are not necessary. The stations have been strategically located in regions where there are no inhabitable star systems or repair facilities within a reasonable travel distance. Since deep space stations cater to large numbers of passengers, the recreational facilities are more elaborate than those usually found at star bases.

K-Class space stations are located in remote and little-developed regions of the Federation, and are intended for the support of colonization efforts on the Federation frontier. This role requires the station to have large storage areas for supplies being shipped to the colonies, as it would be uneconomical for large cargo ships (the only kind that can reach the frontier) to visit each colony. With a central distribution point, the colonies can obtain supplies as needed with little delay and at lowest cost. These stations have extensive refueling facilities, since new colonies generally do not have their own fuel-producing plants.

Outpost monitoring stations are small installations established by Star Fleet to keep watch over sensitive regions of the Federation. A monitoring station may be based on a planet, or located in an asteroid moved into the desired position, and normally consists of a large sensor array, support equipment, and crew quarters. For the most part, monitoring stations are located along the foreign boundaries in the Federation, such as those along the Romulan Neutral Zone. Recently, the Epsilon series of monitoring stations were constructed near the boundary of the Klingon Empire to gather intelligence data and watch for any violation of the Organian Peace Treaty. Due to the classified nature of the function and their limited facilities, they are normally off limits to civilian craft.

Located in the *XY* plane of the Federation is a network of 32 automatic communications relays, small planetoid-based stations designated by a greek letter and number; Alpha-1 for the first relay in Quadrant 1, Alpha-2 for the second, and so on, up to Delta-8 for the eighth relay in Quadrant 4. These stations broadcast a periodic space conditions report, prepared by the UFP to inform vessels of sudden changes in travel conditions: unpredictable events like large solar flares, novae and ion storms can change a safe region of space into a hazardous one almost instantaneously. Relay stations can also receive subspace messages transmitted by starships, and rebroadcast them at much greater power levels, which effectively connects any vessel with any other vessel or planet within broadcast range of the Interstellar Communications Network.

The final aid based at space stations is the search and rescue unit. Every station maintains at least one rescue ship in constant readiness. Whenever an emergency call or disaster beacon is detected, one of these ships is launched to investigate, and give aid where possible. It is a major offense to ignore a distress signal. All ships receiving a distress call must respond with all due haste and render all possible assistance.

3.6 DEEP SPACE PROCEDURES

While the basic techniques of navigation described will get a ship from place to place, the high traffic density in some regions of the UFP have made it necessary to establish operating procedures for spacecraft. The procedures are divided into two classifications: near space operations, those close to a star system; and deep space operations, those between star systems.

It is possible to get to any place in known space by setting up a series of course legs and then following them. This is not recommended for routine travel because, should an emergency arise while on a non-standard route, a ship may be so far from aid that rescue would be impossible. Many ships

have disappeared without a trace on what looked like a simple voyage. The space lanes should be used whenever possible, because aid is quickly available should it be needed.

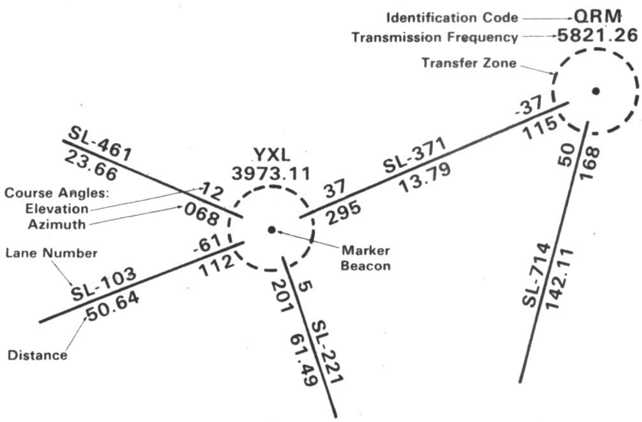


Figure 3.6 Space Lanes

A typical group of space lanes, as they appear on the standard charts, is shown in figure 3.6. The location of each reference beacon is shown, along with its call sign and subspace transmission frequency. Each lane segment has an identification number and length. At each beacon the bearing for the lane to the next beacon is given. Around each beacon is a transfer zone, which is the volume used by ships to change lanes. It is also used to enter or exit the lane system. To use the space lanes, a course is plotted to the nearest reference beacon; when the ship enters the transfer zone, it is maneuvered into the selected lane and positioned on the directional beam in the proper ring for its direction. When the ship reaches the transfer zone at the end of the lane segment it transfers to the next lane segment. This is continued until the reference beacon closest to the destination is reached. A direct course from that beacon to the final destination is then followed. Extra caution must be observed when in a transfer zone to avoid other spacecraft, since a large number may be in the zone.

All interstellar spacecraft are equipped with subspace radio, the primary means of communication over interstellar distances. Conventional, or electromagnetic, radios are of limited use because their signals can travel only at the speed of light; too slow for interstellar use (but still useful for short range applications such as between ships orbiting the same planet or between a ship and landing party). The major difference between subspace and conventional radio is that the speed of propagation of a wave in subspace is proportional to the strength of the signal; the stronger the signal, the faster it will travel. In addition, a directional beam will travel faster than an omnidirectional beam of the same power. The amplitude of the signal decays over time, eventually reaching a level too low to be detected; this imposes a range limit on subspace transmissions, and the result is that stronger signals can be received more quickly and at greater distances than weaker ones. In practical terms, signals from large installations, such as communications relays and star bases with high-power transmitters, are received sooner than those from spacecraft, which cannot carry transmitters as powerful. This means that although a starship can receive messages from its home base in relatively little time, a reply may take weeks, or may never reach the base at all.

Specific subspace frequencies are assigned to routine message traffic and should be used whenever possible. Another group of frequencies, the so-called hailing frequencies, are set aside for short-range ship-to-ship and ship-to-planet communications. These frequencies are spread over the entire electromagnetic and subspace spectrums. Any ship should be able to receive at least one. Emergency transmissions are assigned to still another frequency band, monitored at all times by ships and fixed stations.

3.7 NEAR SPACE TECHNIQUES

Near space techniques concern the operation of a spacecraft within a star system, and vary somewhat depending on the traffic density of the system. For all explored systems within the UFP a detailed approach chart is available. These charts show in great detail the orbits of the various stars, and planets, and their satellites, in the system along with other objects such as asteroid belts and comets. Unusual conditions, large radiation fields, for example, are also marked. The inclination of each object, along with a reference position relative to the grid system and orbital velocity data, is provided so that its present location can be calculated. In some cases, where a system has heavy traffic, additional charts are provided of the major planets indicating approach patterns, and any special conditions such as power transmission and communications beams from satellites.

In addition to the approach charts, a classification system has been set up to group star systems according to their traffic and control facilities. A class number is assigned to each star system with higher numbers going to systems with greater traffic. This numbering should not be confused with the letter system that classifies individual planets according to their composition and environment.

If the star system has no routine traffic (class 0), the procedure is very simple: enter the system from any direction and establish a standard synchronous orbit around the planet of interest. Conditions of this nature are normally found only in an unexplored system.

Class 1 and 2 systems have moderate traffic densities, with a few ships arriving and departing at any given time. The procedures in these cases are not much more complex. The approach charts of these systems show an identification boundary located outside the orbit of the last planet of the system. Any spacecraft crossing this boundary must identify itself to the system's space control. The space control operator will then acknowledge entry and provide information on the other ships in the system. With this information, a course may be plotted to the planet of interest and a standard orbit established.

When entering a system with high traffic density (class 3 or 4), the procedures are more complex. All spacecraft entering such systems must use the approach position reference system, and turn over maneuvering control to an external traffic computer system. This external control is necessary to prevent collisions, as a large number of ships, as many as several thousand at any given time, are all converging on the same point. The approach position reference system consists of four beacons equally spaced in an orbit just inside the identification boundary of the system, as shown in figure 3.7. Taken together, they form a square with each beacon located at each corner. Each beacon transmits a very narrow directional beam which changes frequency as it scans from one edge of the square to the next. Since each point inside the square will receive only one combination of frequencies from the beacons, position can be quickly determined by comparing the frequencies received with a reference table. The traffic computer system is composed of a sophisticated computer, which keeps track of all spacecraft within the system, and calculates the optimum path and orbital position for each ship. It then transmits maneuvering instructions from the beacons to all ships in the system.

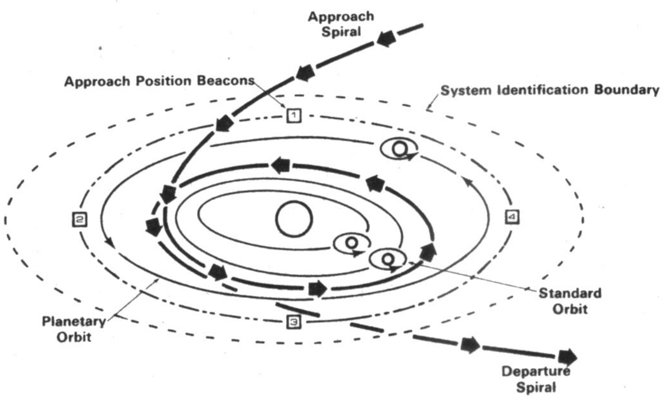


Figure 3.7 Approach Procedures

Ships approaching a system generally follow a spiral that is above the plane of the ecliptic of the system and in the direction of the orbital motion of the planets; departure spirals are from below the ecliptic, and in the direction of orbital motion.

4.0 REGULATIONS

Early in the history of the Federation few regulations, if any, were needed to insure safe interstellar travel. It was thought that the distances involved were so vast and the vessels so few that regulation of traffic would never be needed. With the large increase in interstellar traffic following the development of the time warp drive, it became obvious that such regulations would, in fact, be necessary to prevent collisions in heavily populated space, and to insure the competency of starship pilots. A federation agency was appointed to supervise three major areas: the design safety, maintenance, and operation of space vessels; regulations governing traffic between star systems; and those governing traffic within a star system.
systems; and those governing traffic within a star system.

4.1 SHIP REQUIREMENTS

Every interstellar spacecraft must fulfill certain requirements concerning crew and equipment; for example, the captain of the ship must have a first class master's license, and all crew members must have licenses appropriate to their duties. The spacecraft itself must be inspected at regular intervals to insure that critical components and equipment are operable, and the propulsion and life support systems properly maintained. Safety-related items such as environmental suits and life support belts are mandatory, and on larger ships shuttlecraft or lifeboats are required. Starships must have emergency transporters capable of sending the entire ship's complement down to a planet's surface.

4.2 DEEP SPACE OPERATIONS

The most important prerequisite to deep space travel is a flight plan. All ships except military vessels on special missions must file, with the space control of the system they are departing, a flight plan containing a description of the route to be followed, including any stops, and an estimated time of arrival at the final destination. If any major changes have to be made following departure, the space control where the plan was originally filed must be informed via the inroute communications system. A flight plan gives some idea of the traffic flow, and provides a starting point for a search if the ship is overdue at its destination.

Ships traveling in deep space must be aware of special regions that are proscribed as hazardous or quarantined under Federation mandates. *Warning areas* are regions where hazardous operations may be taking place, such as gunnery practice or war games. *Danger areas* include major hazards to navigation, such as novae and black holes, and areas where unusual and possibly hazardous operations take place on a regular basis. *Prohibited areas* are regions where contact by any spacecraft is forbidden, such as critical Federation installations, and star systems protected under the Prime Directive of Non-interference.

In addition to the special regions set up by the UFP, the star systems in Federation space that are not members have, in some cases, set up their own regulations governing the operation of spacecraft within their zones of influence. For example, the Melkotian system until recently requested that spacecraft not enter its territorial sphere, and placed warning buoys to that end on the border of its space. Detailed information regarding the regulations that apply in such systems can be found in the *Space Operations Handbook*, under the reference number of the region.

Emergencies in deep space are rare, but when one does occur, immediate action is necessary to prevent possible catastrophe. All spacecraft are required to carry an identification beacon which can be used to transmit an emergency signal, and large spacecraft have in addition a recorder-marker which can be ejected at the first sign of danger.

These beacons are to be used only in the event of an emergency which is defined as a situation in which loss of life or the destruction of a ship is imminent and the prompt summoning of assistance is critical. The use of an emergency signal at any other time will result in severe penalties. An emergency immediately takes priority over all other activities. Any spacecraft receiving an emergency signal must make all possible efforts to render assistance. While Star Fleet search and rescue units are dispatched whenever an emergency signal is detected, it may be some time before they arrive; thus the aid that can be provided by other spacecraft in the region of the emergency is critical. The difference of only a few minutes in aid reaching a ship can be crucial. There are severe penalties for the commander of a ship that does not respond to an emergency.

4.3 NEAR SPACE OPERATIONS

The regulations governing ship operations near or inside a star system have as their primary objective the safe movement of large numbers of spacecraft in a limited region. Most of the time the ship will be on its own for the final approach to a planet. Under these conditions the navigator has certain responsibilities. The approach must not interfere with any existing traffic in the system, and must be compatible with any established interplanetary traffic patterns. The orbit established must be clear of communication and power beams, and be at a high enough altitude so that it will not decay. Also, the approach chart for the system should be checked for specific approach requirements and any special or unusual conditions.

Whenever a ship is in a controlled system the space control of the system has the final authority over ship movement. Any instructions received must be followed precisely and immediately. Failure to do so can result in great danger to the other ships in the system. If a ship is unable to comply with the instructions from space control because of equipment failure or other difficulties, space control must be informed of the problem. A rescue ship will be dispatched to assist if the ship is unable to correct the problem on its own. In the event that the ship's radio is rendered inoperative, the ship must maintain its

present course and speed. The space control computer will detect the non-compliance with succeeding instructions, and a ship will be sent to investigate.

5.0 VOYAGES OF THE *ENTERPRISE*

Of the intragalactic starships currently in use, the Constitution class (MK—IX/01 model) is the most sophisticated and certainly the most versatile; no other vessel is capable of crossing the Federation in less than a month, or carries thirteen science labs along with the armament to destroy an entire planet. Starships like the U. S. S. *Enterprise* have been probing the outer regions of our galaxy for over five decades, and have dealt with navigation problems that range from the simple to the extraordinarily complex. They can provide many practical examples of the procedures outlined in this manual.

The first example involves a simple course calculation. On stardate 3013.2, General Order Seven was temporarily suspended when the *Enterprise* traveled from Star Base 11 (where it had been berthed for routine maintenance following an ion storm) to planet four in the Talos star group. Since there were no obstructions between the base and Talos, a direct course was plotted. The bearing to reach Talos IV was determined by taking the position of the star base (−90.00, 0.00, 0.00) and that of the star system (−119.45, −43.73, −24.00) and applying the equations in figure 3.4. The result is a distance to Talos IV of 57.93 parsecs, on a bearing of −27.47 mark 236.04. The *Enterprise* accelerated to warp factor six and reached the Talos system in about six hours.

A course that includes a waypoint is only slightly more complex than a direct one. The *Enterprise* was directed on star date 1704.2 to collect data on the break-up of planet Psi 2000. It had just completed a survey of Alfa 177, and was ready for its next assignment. The direct course to Psi 2000 from Alfa 177 is 38.6 mark 112.6, with a distance of 46.4 parsecs. Unfortunately this course was unusable; it would cause the *Enterprise* to pass much too close to a recently discovered black hole located at (−44.3, −33.9, 46.1). To avoid the black hole, the navigator established a waypoint outside of its influence. Normally the actual location of a waypoint is somewhat arbitrary. Any point in space that would take the course of the ship sufficiently far from the hole would be adequate. However, this time the navigator had another constraint to worry about; the route had to be as short as possible, so that the maximum amount of data on Psi 2000 could be collected. Taking all of these factors into account, the waypoint was positioned at (−43.00, −33.0, −44.0), just beyond the influence of the hole. The first leg of the revised course ran from Alfa 177 on a bearing of 31.5 mark 108.9 for a distance of 24.3 parsecs to the waypoint. The second leg, from the waypoint to Psi 2000, had a bearing of 25.8 mark 116.4 and a distance of 22.2 parsecs. This course had a slightly longer distance, 46.5 parsecs, than the direct course, but it did avoid the black hole and got the *Enterprise* to its destination in time to record the breakup. What happened to the ship and its crew after it reached Psi 2000 had nothing to do with navigation.

Since the *Enterprise* normally patrols the outer regions of the Federation, it does not ordinarily use the space lanes. However, on stardate 3372.7, the *Enterprise* was en route to Altair VI to attend the inauguration of the new system president when it became necessary to detour to Vulcan. Since the region between Altair and Vulcan has a high traffic density, the space lanes provided the fastest route. The *Enterprise* entered the space lane system at the UAZ beacon, taking space lane SL−488 to the YTP beacon. At that beacon, it transferred to space lane SL−107 and followed it to the VLN beacon, which is the closest point to the 40 Eridani system. Since 40 Eridani is a class 4 system, the *Enterprise* requested an approach course from Vulcan Space Central. Approach was authorized, and the *Enterprise* automatically guided by the approach position system into a synchronous parking orbit around Vulcan.

Starships spend the majority of their time traveling between star systems. Very seldom is there any extensive travel among the planets of a system. However, since the *Enterprise* has undertaken a wide variety of missions, such travel has at times been necessary. One example occurred on stardate 4842.6, when the mission of the *Enterprise* was to divert the course of an asteroid. The asteroid was on a hyperbolic trajectory toward UFC−3222877. Its path would take it into the system, around the star on a comet-like approach, then back into deep space. However, as the asteroid approached the orbit of the third planet, Amerind, it would find the planet directly in its path. The resulting collision would devastate Amerind, destroying its humanoid culture. It was therefore planned to have the *Enterprise* use its deflectors to push the asteroid into a new trajectory which would cause it to pass the star at a greater distance, missing Amerind in the process. Unfortunately events did not work out as planned. Delayed by attempts to locate its missing captain, the *Enterprise* was forced to use a higher than recommended speed to reach the calculated deflection point in time. This caused its engines to become seriously stressed. The acting commander still tried to alter the course of the asteroid, but succeeded only in causing a power overload which rendered the warp drive inoperative. The *Enterprise* then fell back on its impulse power for propulsion. Under impulse power a starship behaves like a sublight interplanetary spacecraft. The navigator plotted a return course to Amerind which took into account the position of the *Enterprise*, the orbit of Amerind, and the limited speed available. The resulting course turned out to be the same as that of

the asteroid with a travel time of 60 days. Fortunately, by the time the planet was reached it was discovered how to operate a meteor deflector located on Amerind, and the collision was prevented.

APPENDIX—Star System Data

The following pages provide a brief description of some of the more interesting star systems in and near Federation Space; emphasis is placed on the systems and planets visited during the voyages of the U. S. S. *Enterprise*. The systems are arranged alphabetically, according to their most common names (or those of the principal planets, if the system name is not widely used). Cross-references are given where other names are in current use, and to the previously used constellation nomenclature as well. In some instances, where no proper name has been given to a star system, the constellation designation or a survey number such as the United Federation Catalog (UFC) number is used to identify the system. If the reader is interested in more detailed information on any of the systems described below, the appropriate orientation manual (CM:7XXXXX series publications) should be obtained.

Whenever possible, humanoid cultures are rated on the Richter scale. This scale of cultural development runs from nomadic hunters (A−) to advanced technological civilizations (H+). It provides a quick idea of the social and technical development of a planet. For those interested, a more detailed description of the scale can be found in *Comparative Planetary Anthropology* by Dr. C. J. Richter (SM:000381).

ADHARA [Epsilon Canaris] (−119.0, 105.3, −145.4)
A blue-white giant in a binary system with ten planets and class 2 facilities, Epsilon Canaris (a contraction of the ancient Canis Majoris) supports a large humanoid population on the third and fourth planets, both rating 16 on the Industrial Scale. Although not a UFP member, a Federation embassy has been established on the neutral second planet in the system to prevent a possible interplanetary conflict. Pop: 4.3 billion

ALBIREO [Beta Cygni] (86.8, −67.4, −31.7)
Also known as Cygnia Minor, this is a yellow giant in a triple system (the other two stars are a moderate blue star and a white dwarf), and supports a system of six planets with class 1 facilities. The second planet is Class M, and is the site of a Federation colony established c. 2195. The white dwarf proved to be a variable with a period of 27 years, and planet-wide famine was common during the episodes of high radiation until synthetic foods were developed to withstand these periodic episodes. Pop: 125,000

ALDEBARAN [Alpha Tauri] (10.6, 56.5, −15.1)
Located on the third planet of four orbiting an orange giant in a binary star, the Aldebaran Colony is a major Federation port, with class 3 facilities. The system also contains a red dwarf star orbiting the primary at 97.5 billion kilometers. The New Aberdeen Naval Yards are the sixth largest in the Federation, and the unspoiled wilderness is a popular tourist attraction. A small native population (under one million) is centered around New Aberdeen, which also has a Star Fleet supply center and several private shipyards. Native life, such as the delicious Aldebaran shell-mouth, is generally simple.

ALFA 177 (−36.3, −52.6, −56.7)
The second planet of three orbiting a white dwarf (class 0 facilities), Alfa 177 is only marginally Class M: it has a rotation period of 37 hours, and the surface temperature reaches a nightly low of −160°C. Surprisingly, native life has adapted to the extreme cold, including a species of horned dog-like animals (*Canis Alfa*).

Warning W-399

Certain indigenous ores have been found to possess peculiar magnetic properties, and may interfere with the normal ion-phasing of transporter beams. Inanimate test objects should be transported before any personnel are allowed to beam down.

ALPHA (28.5, 52.8, 19.0)
Alpha III is a system of five planets orbiting a moderate size yellow star (class 2 facilities), is a Federation Member, and one of the seven members of the Federation's security council. Established in the 22nd Century as colony Terra Four, the Statutes of Alpha III is considered to be the most important political document since the Fundamental Declaration of the Martian Colonies, and provided for an independent star system modeled loosely after Plato's "Republic." Pop: 179 million

AL NATH [Beta Tauri] (−66.5, 47.4, 8.1)
A blue giant orbited by thirteen planets (class 0 facilities), the second of which is Class M. The dominant life-form on Taurus II is an anthropoid, about 2.5 meters in height and extremely hostile. Pop: 145 million

ALPHA AQUILAE — see: *ALTAIR*
ALPHA AURIGAE — see: *CAPELLA*
ALPHA BOOTIS — see: *ARCTURUS*
ALPHA CARINAE — see: *CANOPUS*
ALPHA CENTAURI — see: *AL RIJIL*
ALPHA CYGNI — see: *DENEB*
ALPHA LYRAE — see: *VEGA*

ALPHA MAJORIS (−154.5, −17.5, −73.6)
A system of two planets orbiting a red giant (class 0 facilities), Alpha Majoris has no corporeal native life. The first planet is the home of the Mellitus, a semi-intelligent plasma-based creature. Discovered c. 2215, the star system is at present uninhabited.

ALPHA PROXIMA (142.4, −99.1, 42.1)
One of the first extra-solar colonies established, Alpha Proxima is the second planet of twelve orbiting a yellow star (class 3 facilities). The port city of Heliopolis has a population in excess of 3 million, and the planet has a total population of almost 12 million. Major industries include mining and farming, as well as sea-farming in the planet's major oceans.

ALPHA SCORPII — see: *ANTARES*
ALPHA TAURI — see: *ALDEBARAN*

AL RIJIL [Alpha Centarui] *(24.6, 62.5, – 1.0)*

A triple system, with seven planets orbiting a pair of yellow stars. The third star is a red dwarf. The fourth, fifth, and seventh planets are Class M, and all support humanoid life (class 4 facilities). The seventh planet was already inhabited when the system was first explored by the starliner *Enterprise* in 2039, apparently by descendants of ancient Greeks transported from Earth (Sol III) in the third century B. C. This planet became the home of Zefram Cochrane in his later years, until his disappearance on his last voyage in 2089. Alpha Centauri was one of the five founding systems of the Federation, and now supports a population of 21 billion—second only to the Sol system.

ALTAIR [Alpha Aquilae] *(27.9, 59.8, 2.5)*

A white star orbited by eight planets (class 2 facilities), two of which (IV and VI) are inhabited by a native humanoid population rating H on the Richter Scale of Cultures. The two worlds have recently ended a decade-long civil war, and a single system president now governs both worlds. A Federation embassy has been established on the sixth planet. The fourth planet is also of archeological interest for the ruins of the Krell civilization that flourished there millions of years ago. Pop: 7 billion

AMERIND *(– 93.5, – 157.6, – 166.2)*

The fourth planet of eight circling a yellow star, Amerind is a Class M world inhabited by the descendants of American Indians taken from Earth (Sol III) thousands of years ago by an advanced culture known only as the Preservers. Pop: 18.3 million

Danger D-868

The Amerind system is located in a dense asteroid cluster, and planetary debris is traveling through the system on uncharted trajectories. Spacecraft should exercise due caution when approaching.

ANDOR [Epsilon Indi] *(25.8, 60.1, – 2.4)*

An orange dwarf with nine planets (class 3 facilities), Epsilon Indi is the home world of the Andorian race, an insectoid species that was the third intelligent civilization contacted by man. Although in a feudal state when contacted, approximately D+ on the Richter Scale, the Andorians quickly assimilated Earth technology, and are now a major Federation member. In addition to the Andorians, who evolved on the eighth planet, Epsilon Indi III, or Triacus, was once the seat of a pirate empire, composed of several humanoid cultures, that became extinct shortly before the Vegan Tyranny. Triacus, although Class M, is uninhabited. Pop: 17.2 billion

ANTARES [Alpha Scorpii] *(172.1, 118.9, – 13.9)*

A binary system consisting of a red giant primary and a small yellow secondary (class 0 facilities), Antares supports a total of nine planets, four orbiting the primary and five the secondary. Neither system is inhabited, but both support a number of interesting life-forms, such as the Antarean dryworm. Antarean "glow water," the dryworms suspended in a liquid environment, is a popular trade item.

ANTOS *(18.1, – 20.4, – 6.1)*

A yellow giant with five planets, with the fourth being Class M (class 0 facilities). Antos is the home of a humanoid race that is considerably older than mankind and has little interest in contact with the Federation. Like the Vendorians, the inhabitants of Antos IV have perfected the technique of cellular metamorphosis, and can rearrange their cellular structures to imitate that of any object of about the same size and mass. The Antosians have not been extensively studied, but their population appears to be under 100,000.

ARCTURUS [Alpha Bootis] *(27.6, 70.4, 6.6)*

An orange star with five planets (class 1 facilities), Arcturus supports a humanoid population on its fourth planet roughly comparable to Elizabethan England (Approximately C– on the Richter Scale). Arcturian mode of dress and dramatic conventions have been adopted by many Federation cultures. Pop: 350 million

ARDANA [Mu Leonis] *(8.5, 106.3, 9.8)*

A Federation member, Ardana is the third planet of three circling Mu Leonis A, a red star in a binary system (class 1 facilities). Ardana's humanoid population, contrary to native tradition, is probably not native; early colonists, rather than endure life on the planet's inhospitable surface, constructed the remarkable antigravity city of Stratos. Unfortunately, the ground dwellers, or "troglytes", were forced to undergo a separate and unequal evolution in the zeinite mines, and the planet now supports two widely disparate castes. The caste differences are now being eliminated at Federation request. Pop: 600,000

ARGELIUS *(– 154.7, – 59.2, – 121.2)*

The second planet of ten orbiting a yellow star in a binary system, Argelius II (class 2 facilities) is well known for its hospitality and for the peaceful nature of its inhabitants. Since their Great Awakening two centuries ago, Argelians have deplored violence, and welcome space travelers of any affiliation. Pop: 1.7 billion

ARGUS *(– 9.0, – 99.8, 69.0)*

A white dwarf with ten planets (class 0 facilities), Argus is remarkable only for the native "vampire cloud," a non-corporeal life-form that evolved on the barren tenth planet. The atmosphere of Argus X was recently torn away by an anti-matter explosion.

ARIANNUS *(– 30.7, 57.6, – 20.4)*

The fourth planet of seven orbiting a yellow star, Ariannus is a farm world, supplying agricultural produce to many nearby worlds. Ariannus supports a modest population of under a thousand, composed mainly of farmers (class 2 facilities).

ARRET *(– 36.1, – 136.3, – 98.5)*

The first planet of an orange star (class 0 facilities), Arret was Class M until its atmosphere was torn away, rendering the surface uninhabitable. Subsurface ruins suggest that an advanced humanoid civilization once flourished in this system, and ancient records name four inner planets that no longer exist. It is thought that the star was originally a yellow dwarf much like Sol, and became a nova millions of years ago.

AXANAR *(– 51.5, 5.2, – 8.1)*

The first planet of three orbiting a yellow dwarf (class 1 facilities), Axanar supports a primitive native population (D– on the Richter Scale) that allied itself with the Klingon Empire during the Four Years War in the 2240's. Efforts by the Klingons to construct a naval base on Axanar resulted in the famous blockade of the system by Captain Garth; later, the Axanar Peace Mission established the current Federation-Klingon border, and insured the neutrality of Axanar. Pop: 150 million

BABEL [Wolf 424] (24.2, 66.1, 0.8)

Babel is the code name for a planet about 4,200 km in diameter, the largest of several dozen, circling the red dwarf Wolf 424 (class 1 facilities). Chosen for its central location, Babel became the site of a conference to evaluate the Coridan system's application for Federation membership in 2262. Babel was terraformed for humanoid habitation, and since then plans have been approved for a permanent conference facility on the planet.

BENECIA (−0.6, −59.7, −313.0)

This system, eight planets around a small blue star, supports a small human colony on the third planet (class 1 facilities). Chief industries are forestry and exportation of native raw materials; the colony has a number of small villages, but its population of 12,500 is widely distributed over two major continents.

BERENGARIA (−21.4, −51.8, −60.3)

A giant red star orbited by thirteen planets (class 0 facilities), Berengaria has no sentient life, although many life-forms inhabit the seventh and eighth planets. The dominant species on Berengaria VII, a flying dragonlike reptile, may eventually evolve intelligence.

BETA AURIGAE	*see: Menkalina*
BETA CYGNI	*see: ALBIREO*
BETA GEMINORUM	*see: POLLUX*

BETA NIOBE (−73.1, −166.7, −210.1)

Formerly a large yellow star with five planets and one inhabited world, Sarpeidon, Beta Niobe became a nova in 2263.

Danger D-549

Novae emit intense radiation that can be lethal to humanoid life. Spacecraft should avoid passing within ten parsecs of this star.

BETA OPHIUCHI	*see: CHELEB*
BETA ORIONIS	*see: RIGEL*

BETA 6 (−109.1, −106.3, −74.2)

A system of seven planets orbiting the secondary star in a double system, the Beta 6 Colony is located on the sixth planet of a moderate yellow star. Established in 2195, Beta 6 is now a thriving humanoid colony (primarily human and Andorian) with class 1 facilities and a population of 87,000.

BETA TAURI	*see: AL NATH*

BETA XII—A (−195.0, 61.7, −54.3)

The site of an experimental agricultural colony (class 1 facilities), Beta XII—A is one of two worlds in a trojan orbit around a common center of gravity (the Earth-Luna system is another example of such a trojan orbit). Beta's primary is a dim orange star, and has a total of thirteen planets. Pop: 112

CAMUS (−55.0, −62.8, −360.2)

An orange star with four planets (class 0 facilities), Camus was once the site of an advanced civilization that apparently never developed space flight, although it excelled in sciences previously unknown to the Federation. The second planet is Class K, approximating Mars conditions, and has extensive surface ruins.

CANOPUS [Alpha Carinae] (15.4, 63.7, −28.7)

A bright yellow-white star with eight planets (class 1 facilities), Canopus has developed life on three of its planets, and intelligent life on two. Canopus III, a low gravity world, is the site of an advanced technological civilization that evolved from birdlike ancestors; the inhabitants of this world recently attained interstellar travel, although application has not been made for Federation membership. Canopus II is inhabited by primitive aborigines, rating approximately A+ on the Richter Scale. Canopus V has a number of interesting life-forms, including the Drella, a small koala-like animal that is sensitive to human emotions. Total system population: 3.7 billion

CAPELLA [Alpha Aurigae] (11.1, 60.0, 4.6)

This system contains four stars. Two of them are yellow stars forming a binary pair. They are orbited at a distance of 0.17 light-year by a binary pair of the other two stars, red dwarfs. The only inhabited planet in the system is the outermost of four orbiting the central yellow binary pair. A Class G desert world, Capella IV has a small population of nomadic humanoids, generally believed to be the descendants of the Ceres expedition lost in 2084. This planet supports a number of other chordate life forms, including the vicious Capellan power cat. Pop: 4,100.

CESTUS (−44.2, −169.1, −113.9)

Fourteen planets orbit this blue star (class 2 facilities), and a Federation colony and support base was located on the third planet. The entire population of 178 colonists was destroyed in a recent Gorn attack. Construction of a new base has been delayed pending a peace treaty with the Gorn Hegemony.

CHELEB [Beta Ophiuchi] (56.2, 65.7, 20.1)

The sixth planet of nine orbiting Beta Ophiuchi, an orange supergiant (class 1 facilities), is a Class M world that supports a small pergium mining colony commonly known as the Ophiuchus Colony. Pop:28

CORIDAN (29.7, 64.3, 29.9)

The Coridan system has a total of four inhabited worlds, more than any other system except for Rigel and Sol. The humanoid life-forms native to Coridan evolved on the third world of a system of ten planets orbiting a red dwarf (class 1 facilities). After the development of interplanetary flight, colonies were established on the fourth, seventh, and ninth planets, Class M, F, and G worlds respectively. Rich dilithium deposits were recently discovered on Coridan IX, the most thinly-populated planet in the system. Total pop: 790 million

Warning W-223

The Coridan system is not at present a member of the United Federation of Planets. Special regulations govern the entry of Federation spacecraft to this system.

CYGNET (54.5, −30.0, −22.4)

A binary system consisting of a blue-white giant and a red dwarf, Cygnet supports fifteen planets, and one inhabited Class M world (Cygnet XIV). A Federation member, Cygnet XIV is a highly advanced technological world with a matriarchal society (Cygnian males are only semi-intelligent). Cygnet has a Star Fleet support base with class 3 facilities, run entirely by females.

CYGNIA MINOR see: *ALBIREO*

DARAN (−127.5, −139.2, −19.7)
A moderate orange star orbited by ten planets (class 3 facilities), Daran is a Federation member with a humanoid population of 3.7 billion on the fifth planet. Originally an Earth colony, Daran has a large Deltan and Tellarite population as well, and is a major industrial center in a relatively unpopulated quadrant.

DELTA DORADO see: *GIDEON*

DELTA VEGA (140.9, 47.7, 187.8)
A white dwarf on the northern fringe of the galaxy, Delta Vega has only one planet, a Class F world with only primitive life and a primordial atmosphere. An automated dilithium cracking station is located on this world, and ore ships call only once every twenty years; the system has class 1 facilities that are totally automatic.

DENEB [Alpha Cygni] (142.7, −143.4, 382.5)
A major star system with a population of over 29 billion, Deneb ranks with Sol and Rigel as one of the major cultural centers of the Federation, and its location above the galactic ecliptic makes it one of the most remote of Federation members. A system of five planets orbiting a white supergiant in a binary system (class 4 facilities), planets II, IV, and V are Class M and support intelligent life. Deneb III is Class N, and has several interesting non-sapient life-forms. Deneb II has an advanced native population with a population of about 1.8 billion, and is on the verge of interstellar flight, with a Richter rating of G−. Deneb IV has a small Federation colony (Pop. 17,000) and supply base, but is largely unspoiled wilderness. Deneb V is the most heavily populated world in the system, and is a major Federation port with a Star Fleet training center, extensive naval yards, and the newly-opened Academy of Sciences. Originally a colony of Deneb II, it still supports a large Denebian population.

DENEVA (45.8, 52.8, 96.9)
The third planet of seven orbiting a moderate white star, Deneva was colonized in the 2160's as a trading base between the mineral-rich Denevan asteroid belts and the Federation industrial worlds. It now has a human population of over 1 million, mostly centered around the port city of New Sacramento, and is still the home system of several interstellar freight lines (class 2 facilities).

DIMORUS (−26.7, −18.8, −27.9)
The fourth planet of eight orbiting a pair of moderate orange stars (class 0 facilities), Dimorus has a native population of intelligent rodent-like creatures which rate about C− on the Richter Scale. Extreme xenophobes, they have attacked several Federation contact teams, and the planet has been placed under quarantine until further notice.

EDEN (−146.6, −190.1, 2.8)
Originally a world of mythical beauty described by shipwrecked survivors of the Romulan War in the 2160's, Eden was recently identified as the only planet of a moderate white star (UFC 3676543) with class 0 facilities in the Romulan Neutral Zone. It has no animal life, and the native flora has been found to contain extremely corrosive acid.

Prohibited P-091

Entry into the neutral zone by any Federation vessel is a violation of interstellar treaty, and is expressly forbidden.

ELBA (−18.3, −119.4, −7.1)
A white dwarf binary with two planets (class 1 facilities), the Elba correctional facility for the incurably insane is located on the second planet. Since the planet is Class F with a poisonous atmosphere, the facility is located inside a pressure dome. Current population of staff and inmates: 14

Prohibited P-137

Elba is a restricted area, and only authorized spacecraft are permitted to enter this system.

EMINIAR (−37.0, 222.3, 25.1)
A large yellow star in a dense stellar cluster, Eminiar has eleven planets, two of which are inhabited: Eminiar III (Vendikar) and Eminiar VII. Both have a very advanced humanoid civilization, which evolved originally on the seventh planet and later colonized Vendikar. The inhabitants of this system recently ended a five-century-long interplanetary war, and are currently negotiating a trade agreement with the Federation. Class 3 approach facilities are being installed.

EPSILON BOOTIS see: *IZAR*
EPSILON CANARIS see: *ADHARA*
EPSILON INDI see: *ANDOR*
ETA SERPENTIS see: *TUNG HAE*

ETA SERPENTIS (40.8, 61.6, 7.2)
Colony Terra Five (class 2 facilities) is located on the sixth planet in this system of eight planets orbiting a moderate size yellow star. Established in 2170, the colony now supports a thriving population of 850,000 and has several large cities and universities, as well as a Star Fleet support base.

EXCALBIA (−54.8, −157.7, −193.4)
The first of three planets orbiting a blue-white giant (class 0 facilities), Excalbia is Class D with a surface of molten lava. The inhabitants of Excalbia are intelligent carbon-cycle beings with a chemistry based on calcium carbonate. Contact with these entities is limited to authorized contact teams.

EXO (52.2, 74.1, 70.6)
This system consists of four planets orbiting a small red star which has begun to contract due to helium burning within the last 30,000 years. The third planet, at one time Class M and inhabited by a vaguely humanoid race, is now uninhabitable, with a mean surface temperature of −50°C; extensive ruins beneath the glaciated surface suggest an advanced civilization that never developed space flight.

FABRINA (−126.1, −144.7, −7.8)
Formerly a moderate size yellow star with eight planets, including one inhabited Class M world. It became a nova 10,000 years ago, and is now the site of a neutron star and an expanding nebula. The only known survivors are the inhabitants of Yonada, a multi-generational asteroid starship.

40 ERIDANI (19.5, 60.0, −0.6)
A triple star system composed of a large orange star and two dwarf companions, the 40 Eridani system has two planets, both circling the orange primary. The first planet is Vulcan, a large, Class M world with a high surface gravity and temperature, the home world of an advanced and highly intelligent civilization that predates mankind

by several millenia. The Vulcanoid species is the second most common humanoid type in the Federation. The Vulcan Science Academy and several large port cities are located on this planet, and almost a fifth of the system's population of 14.9 billion lives in the system's heavily industrialized asteroid belt. The other planet of 40 Eridani A is an airless Class J planet with a population under 50,000. (class 4 facilities)

GAMMA HYDRA (36.9, 87.9, −18.6)
A giant yellow star orbited by six planets (class 0 facilities). The fourth planet is Class M, and at one time was the site of a Federation outpost colony.

Danger D-361

Gamma Hydra IV recently passed through the radioactive tail of a comet, and the resulting surface radiation may cause hyper-aging in unprotected humanoids. This planet should be avoided until the surface radiation decays to safe levels.

GAMMA 7 (134.5, 176.7, 11.7)
At one time this binary system supported a population of seven billion on four of the seven planets orbiting Gamma 7A, a fourth magnitude yellow star and the primary star of the pair. The secondary star, a moderate blue star, has no planets. All life in the system was destroyed by a space amoeba.

GAMMA TRIANGULI (−170.5, −126.0, 91.6)
A yellow giant with eleven planets (class 0 facilities), Gamma Trianguli has a primitive humanoid population (*Homo Trianguli*) of less than one thousand individuals on its sixth planet.

Prohibited P-311

This system is protected under the Prime Directive of Non-Interference, and only authorized contact with its natives is permitted.

GAMMA VERTIS (26.8, 200.4, 7.8)
Gamma Vertis is a moderate size orange star (class 1 facilities) with six planets, five of which (planets II through VI) are actually satellites of a massive Class A gas giant. Gamma Vertis IV is a low-gravity world, and supports an advanced but non-technological humanoid population which communicates telepathically. Pop: 1.6 billion.

GIDEON [Delta Dorado] (54.5, 42.7, −242.9)
Gideon is the seventh planet of eight orbiting a bright white star (class 1 facilities), and has repeatedly refused to establish diplomatic relations with the Federation. At one time almost completely germ-free, Gideon suffered from extreme overpopulation (estimated in 2263 at over 500 billion, surpassing the total population of the Federation), but the recent introduction of Vegan choriomeningitis wiped out almost 97% of the planet's population.

GOTHOS (last known position: −132.6, −125.7, −114.3)
A Class H planetoid of magnitude 1-E (class 0 facilities), Gothos is a rogue traveling without a primary through an otherwise empty sector of space. It has a poisonous atmosphere, but areas have been terraformed by intelligent non-corporeal life-forms.

Prohibited P-140

A dangerous life form may be present on the surface. It is extremely hazardous and contact with this planetoid must be avoided.

HALKA (−29.2, −137.3, −6.7)
The second of three planets orbiting a giant red star (class 0 facilities), Halka has a peaceful humanoid population with little interest in a Federation alliance. Large deposits of crude dilithium are known to exist on Halka. Pop: 580 million

HANSON'S PLANET (188.8, 34.9, 12.6)
A Class M planet, the first of three circling UFC 2848832, a white dwarf (class 0 facilities). Although inhabited by a race of large, furry anthropoids (*homo hansonii*), the planet has a mean temperature of 0°C, and is not suitable for humanoid life.

INGRAHAM (52.0, 39.9, 27.9)
A moderate white star with two planets in a trojan orbit (class 0 facilities). Ingraham B, the smaller of the two, is Class M, and was once the site of an advanced spacefaring civilization that was destroyed by the flying parasites in 2259. Although only vaguely anthropoid, the Ingrahamites had a limited trade agreement with the Federation.

IZAR [Epsilon Bootis] (36.7, 84.7, 17.6)
The third planet of five orbiting a small orange star in a binary system, Izar is a heavily populated world with class 3 facilities. The other star in the system is a small blue one. An early Earth (Sol III) colony, Izar is now an independent world within an industrial sector of the Federation. A Star Fleet training base and several large cities are located on the major continent of Pangaea. Pop: 11.5 billion

JANUS (−123.8, −30.1, −15.8)
A moderate orange star orbited by ten planets (class 1 facilities). None of the planets are Class M, but the sixth planet is Class H, with rich veins of pergium and other super-heavy elements. A mining colony is located in an extensive network of subsurface tunnels on Janus VI, and supplies the reactors of several dozen neighboring worlds. The only known intelligent silicon-based life-form, the horta, is native to Janus VI, and currently controls a one-half interest in the mining colony. Humanoid population: 157

KAFERIA [Tau Ceti] (22.8, 58.7, −1.5)
The third planet of five orbiting the moderate size yellow star Tau Ceti (class 1 facilities). Kaferia was one of the first non-human civilizations contacted. A race of intelligent insectoids, the Kaferians have had profitable trade relations with the Federation for almost two hundred years. Their chief exports are flora and fauna genetically tailored by Kaferian biologists. Pop: 7.2 billion

KALANDAN OUTPOST (12.8, 231.2, −34.0)
The only planet of a moderate yellow star (class 0 facilities) on the fringe of Federation space, this world is either an artificial construct of the ancient Kalandans or an extremely dense asteroid tailored for their purposes. Although only slightly larger than Earth's moon, it is class M, with a barren but viable surface ecology. The planet was apparently abandoned several million years ago when disease killed the outpost personnel.

L-370 (−217.9, 7.2, −141.4)
Originally, seven planets orbiting a moderate orange star. All the planets in the system were destroyed by an intergalactic berserker.

L-374 −215.7, 7.5, −139.5)
A red giant originally orbited by eight planets. The first three planets were destroyed by the berserker.

LAMBDA PERSEI *see: TYPERIAS*

LAVINIUS (140.7, 11.1, −10.4)
A bright blue star with ten planets (class 0 facilities). At one time, the fifth planet was inhabited by an intelligent spacefaring civilization that predates the Vegan Tyranny. Little is known of this civilization, as the inhabitants seem to have destroyed most of their own artifacts after the invasion of flying parasites two hundred years ago.

M 24—ALPHA (−85.5, −59.1, −75.8)
Triskelion is the second planet of a moderate size yellow star in this trinary system composed of two yellow stars and a white dwarf orbiting a common center of gravity (class 0 facilities). Once the home of an intelligent technological civilization, the Triskelions now exist only as disembodied intellects in subsurface vaults. The planet has a small and very disparate humanoid colony, which was recently given self-government through Federation intervention. Pop: 480

M 43—ALPHA (72.8, −29.1, −68.7)
A trinary system, with ten planets orbiting the moderate yellow primary (class 0 facilities). The fourth planet, Ekos, and the fifth planet, Zeon, are Class M with large humanoid populations. Although Ekosians and Zeons are branches of the same humanoid race, both planets claim to be the species' home world. The late John Gill was Federation cultural advisor to this system. Total pop: 16.1 billion

Prohibited P-394

This system is protected under the Prime Directive of Non-Interference, and any unauthorized contact with its natives is expressly forbidden.

M 133 *see: UFC 113*

MAKUS (—8.6, 124.6, 32.5)
The third planet of eight orbiting a moderate size yellow star (class 2 facilities), Makus is a frontier world, colonized within the last century. In addition to a small Star Fleet supply base, the planet supports a thriving agricultural colony (pop: 71,000) which exports native foodstuffs and pharmaceuticals.

MALURIA [Omega Cygni] (58.2, 9.1, 14.6)
A system of ten planets orbiting a red-orange giant, and at one time the home system of an advanced and peaceful humanoid race with remarkable prescient abilities (pop: 4.0 billion). A small Federation contact team was situated on planet IV until all four inhabited worlds in the system (planets II through V) were sterilized by the Nomad probe in 2262. Current plans are to re-introduce basic flora and fauna to these worlds for eventual re-colonization.

MANARK (−53.1, −45.1, −12.0)
A red giant orbited by four planets (class 0 facilities), Manark supports no populated worlds, although the fourth planet is Class G and is marginally habitable. The sandbat, native to this planet, is a dangerous avian life-form that can kill almost instantaneously, by injecting carbonic acid into the bloodstream.

MARCOS (26.9, 82.8, −2.2)
The twelfth planet of twelve orbiting a moderate-size orange star (class 2 facilities), Marcos supports a mixed humanoid population, of humans, Vulcans, and Vegans, that has developed a viable form of anarchistic government. Although a Federation member, the colony of about six million is largely self-sufficient, and has resisted entry into the interstellar market.

MARCUS (42.6, −20.4, 10.6)
In a system of four planets orbiting a moderate size red-orange star (class 1 facilities), Marcus is the second world and is the home of a small humanoid society of about 2.4 million. At one time a large industrial civilization rating F on the Richter Scale, the Marcusites never developed space flight, and instead fought a number of devastating nuclear wars. A dwindling population now rates less than E−, and is noteworthy only for its artistic accomplishments, such as those of the reknowned artist Sten, who lived during the last century.

MEDUSA (27.2, 137.6, −41.3)
A binary system composed of a bright white star and a yellow dwarf companion (class 2 facilities), Medusa supports a system of eight planets, the fourth of which is inhabited. Although Medusa IV has been surveyed only by unmanned probes, it is typical for a Class C world, the surface blanketed in dense layers of carbon dioxide. The Medusans, intelligent non-corporeal life-forms, have followed a unique evolutionary path and seem to be largely electromagnetic in nature. Contact between the Medusans and the Federation has been brief (the planet was discovered c. 2257), but they have already demonstrated an extremely advanced scientific culture, and telepathic powers unlike any others in the known galaxy.

MELKOT (−76.9, −145.9, −12.7)
Melkot is the second of six planets orbiting the home of an intelligent non-humanoid race. Although surveyed only briefly, planet II is apparently Class M, with no surface features visible from orbit. The Melkotians have agreed to a limited cultural exchange with the Federation, and additional data is withheld pending the report of the contact team.

Prohibited P-2ll

The Melkotians have established a spherical network of buoys surrounding their home system, and until recently would not allow any spacecraft to enter this region. Until formal trade agreements are completed, the boundaries of Melkotian space are to be respected.

MEMORY ALPHA (116.9, 115.5, 0.0)
Memory Alpha was established in 2229 for the Federation Centennial celebration as a central library-computer complex, providing access for all races to the total knowledge of the Federation. Located on a small Class J planetoid (class 2 facilities) moved into a precise location on the Federation plane, the Memory Alpha complex was opened to the general public in 2231. Partially destroyed by the Zetars in 2263, large sections of the library-computer are now being overhauled. Resident pop: 600

MENKALINA [Beta Aurigae] (−1.4, 61.4, 9.1)
A variable binary system consisting of two moderate yellow-white stars (class 0 facilities), this system is of interest to Federation scientists studying gravity waves, and a small unmanned monitoring station has been established on the only planet of the system's primary.

MERAK (11.2, 72.7, 17.1)
The second planet of four orbiting a moderate white star (class 2 facilities), Merak is an agricultural world colonized c. 2218. Pop: 3,900

MIDOS (42.2, 47.4, 96.9)
A moderate yellow star with seven planets (class 1 facilities), Midos supports a small human colony on its fifth planet, an Earthlike world, rich in natural resources but with no native animal life. Pop: 481,000

MINARA (−193.0, −87.1, −11.3)
Until recently, a yellow giant star orbited by seven planets, the first three of which were class M. Intelligent civilizations are believed to have existed on these three worlds, and a Federation outpost was briefly established on planet I. Minara went nova in 2263, destroying all but two planets.

Danger D-445

Novae emit intense radiation that can be lethal to humanoid life. Spacecraft should avoid passing within ten parsecs of this star.

MIRA [Omicron Ceti] (7.9, 36.1, −8.9)
A binary system composed of a variable red supergiant and a blue subdwarf (class 0 facilities), Omicron Ceti supports a system of five planets, all orbiting the primary. The third planet is Class M, and was the site of a human agricultural colony of several hundred established in 2260 and relocated the following year.

Danger D-389

The variable primary was found to emit Berthold radiation, which quickly disintegrates animal tissue and renders the surface uninhabitable for long periods. Certain sporial life-forms not native to the system actually thrive on the radiation, and their therapeutic effects have prompted a proposal to establish a health resort on Omicron Ceti III.

MU LEONIS — *see: ARDANA*

MUDD (−13.3, 225.1, −45.5)
Named after its only human inhabitant, Mudd is a Class K planet and is the second of five orbiting UFC 257704, a moderate red star (class 1 facilities). It is presently inhabited by more than 200,000 androids left there by an extragalactic civilization over a million years ago, and extensive subsurface tunnels have been adapted for humanoid habitation.

MURASAKI 312 (−66.5, 47.4, 8.1)
The Murasaki objects, first observed in the early 21st century, are quasarlike phenomena that are thought to be rarified gas clouds illuminated by synchrotron radiation. The phenomena may encompass several star systems, and peak at unpredictable intervals (the most intense radiation is at a wavelength of 485 nm).

Warning W-176

Murasaki phenomena have been known to interfere with the electronic sensor and guidance equipment of nearby spacecraft, with the peak effect lasting as long as twenty-four hours.

NEURAL [Zeta Bootis] (57.8, 114.1, 33.1)
This Class M world is the third of ten orbiting a bright yellow star in a binary system (class 0 facilities). The planet, discovered c. 2248, is very Earthlike, and supports a native population rating D− on the Richter Scale. Pop: 13 million.

Prohibited P-388

This system is protected under the Prime Directive of Non-Interference, and any unauthorized contact with its natives is expressly forbidden.

NEW PARIS (−26.3, 200.6, −147.6)
The sixth planet of fifteen orbiting a blue-white giant (class 1 facilities), New Paris is a Federation outpost world colonized c. 2105 by the starliner *Lafayette*. The twin port cities of Cleante and Candide have populations in excess of one million, and export both manufactured goods and farm produce. Pop: 26 million.

OMEGA (−88.4, 224.4, 2.0)
A moderate orange star with eight planets (class 0 facilities), including two inhabited worlds. Omega IV is an Earthlike world populated by humanoids whose development has been remarkably similar to that on Terra; it is widely believed that this planet is a "lost" human colony that has reverted to barbarism, and now rates about B− on the Richter Scale (pop:130,000). Holberg 917G, the seventh planet in the Omega system, is a largely barren Class G world which once supported a neanderthaloid population similar to the Kalar of Rigel VII. It is now owned by a Mr. Brack.

OMEGA CYGNI — *see: MALURIA*
OMEGA FORNACIS — *see: TIBURON*

OMICRON (87.8, 218.8, 131.3)
A moderate red-orange star orbited by eight planets (class 0 facilities), the fourth of which is Class M. Once the site of an advanced humanoid civilization, the surface of Omicron IV was rendered uninhabitable by a nuclear war c. 1930 (Old Calendar).

OMICRON CETI — *see: MIRA*

OMICRON DELTA (−109.4, −6.7, −46.4)
A group of six star systems in an enveloping nebula (class 0 facilities), the Omicron Delta region is believed to be the result of a supernova explosion several centuries ago. The only explored class M world in the region is the fourth planet of ten orbiting a moderate yellow star, a world that was converted into an entertainment complex by an advanced humanoid culture believed to have originated in one of the other star systems in the region. The amusement park planet is entirely automated, and visitors are welcome.

ORGANIA (−112.6, 186.3, −12.1)
Organia, the fourth planet of six orbiting a bright yellow dwarf (class 1 facilities), is the only Class M world in a strategic volume of space between the Federation and

Klingon Empire, and was coveted by both sides as a naval base until the signing of the Organian Peace Treaty in 2261. The inhabitants, apparently a simple humanoid culture rating D− on the Richter Scale, are actually a race of immensely advanced radiant beings that have very little interest in the affairs of corporeal beings beyond the enforcement of a galactic peace. Pop: 14,000?

PLATONIUS (−116.8, −73.6, 65.6)

This Class M planet is the fourth of four orbiting a bright orange star, and the only humanoid inhabitants are refugees from Sandara, a star that went nova several millenia ago. The Platonians have utilized the natural abundance of kironide to develop their psychokinetic abilities, and have shown little judgment or compassion in the use of these powers. Pop: 71

POLLUX [Beta Geminorum] (13.9, 65.6, 0.6)

This giant yellow-orange star is orbited by seven planets (class 0 facilities), the fourth and fifth of which are Class M. Both are habitable, but are currently devoid of intelligent life. Planet IV, a parklike world, was the home of a now-extinct humanoid race that visited Earth (Sol III) in antiquity.

Psi 2000 (51.9, −15.1, −34.3)

An unstable yellow subdwarf nearing the end of its main sequence evolution (class 0 facilities), Psi 2000 once supported an extensive planetary system that has since escaped the star's gravitational pull or has been disintegrated into asteroid belts.

Danger D-421

The orbit of Psi 2000's last satellite, La Pig, is now an asteroid belt, and planetary debris is traveling throughout the system on uncharted trajectories. Spacecraft should exercise due caution.

PYRIS (−1.6, −93.4, −2.6)

A blue dwarf orbited by ten planets (class 0 facilities), the seventh of which is marginally Class M. At one time, Pyris was the base of an extra-galactic civilization attempting to gain a foothold in this galaxy.

PLANET Q (4.7, −192.7, −216.8)

A small Class J planetoid, orbiting a moderate yellow star (class 1 facilities), that was terraformed and settled in the early 23rd century as a colony of scientists deliberately remote from the Federation hub. Now a self-supporting colony of almost 450,000, the surface of Planet Q is habitable, if somewhat barren; most of the population still resides within the domed city of New Princeton.

REGULUS [Alpha Leonis] (10.7, 83.9, 0.7)

The Regulus system consists of thirteen planets orbiting a blue-white giant in a triple system (class 1 facilities). The other two stars are orange dwarfs orbiting well outside the region of the planets. Several of the planets are Class M, but only one, the second planet, has developed intelligent life. The Regulans, a non-humanoid race rating G+ on the Richter Scale, have opened the plateaus on their southern continent for human habitation, and a small Federation colony (pop: 16,000) now occupies this region. Regulus V also supports advanced non-humanoid life, including the giant Regulan eel-bird and the Regulan blood worm. Pop: 8.3 billion

RIGEL [Beta Orionis] (−209.9, 7.7, −136.0)

This quadruple star system includes two stars of interest, a blue-white super-giant and a somewhat smaller blue-white giant, and supports a total of thirteen planets, six of which are inhabited (class 3 facilities). This remarkable number of Class M worlds is attributed to the star's extensive habitable zone, and to the Hakel radiation belt which surrounds the system's primary and shields against the lethal radiation emitted by the B spectral class super giant. Rigel II and Rigel IV, sometimes called the Rigel Colonies, were settled by humans within the last two centuries, and are now major Federation worlds with a combined population in excess of 8 billion. Rigel V is inhabited by a peaceful humanoid culture (pop: 1.2 billion) that is thought to be an offshoot of the Vulcan race, and has been a Federation member since the 2180s. Rigel VI and VII are a double planet system in a trojan orbit. Rigel VII, a large Class M world, is inhabited by a belligerent neanderthaloid race called the Kalar, rating about D+ on the Richter Scale (pop: 10,000). Rigel VIII, also known as Orion, is one of the very few inhabited ringed worlds, and supports a native humanoid population of aggressive, yellow-skinned warriors (pop: 5.4 billion). Given interstellar travel by Earth explorers before the implementation of the Prime Directive, the Orions colonized the two planets of Rigel's blue giant secondary star, and then went on to form a pirate empire trading primarily in Orion females, semi-intelligent and green-skinned, but prized for their aggressiveness. This slave trade was ended in the 2250s by Federation intervention, and more recently, the decision to let the Orion worlds remain neutral has been questioned. Rigel XII is a class G desert planet with large deposits of crude dilithium, and supports a small mining colony (pop: 6).

ROMII (−180.0, −156.4, −1.8)

A home star in the Romulan Star Empire, evidently an early colony of Romulus Prime. A white subdwarf with four planets; only one, the first planet, is inhabited. Est. pop: 5 billion

ROMULUS (−176.3, −158.5, −1.8)

The Federation name for the home star of the Romulan Star Empire, a small white dwarf in a binary system. The star is believed to have only two planets, Romulus and Remus, orbiting each other in a trojan relationship. Both planets appear to be class M and show signs of extensive habitation: the total population is estimated at over 20 billion.

SANDARA (−45.9, 147.7, 70.2)

A star with several planets, at least one of which was inhabited. It was destroyed in ancient times by a nova. The only known survivors are the inhabitants of the planet Platonius.

SARPEIDON *see: BETA NIOBE*

SCALOS (−70.1, −121.1, −183.2)

This class M planet is the fourth of eight orbiting a moderate yellow star. The native humanoid population, although technologically very advanced, was exposed to radioactive pollutants which accelerated their rate of metabolism and rendered all male Scalosians sterile. The planet is now uninhabited.

SHERMAN'S PLANET (−171.3, 119.2, −4.3)

Named after a friend of the discoverer, this Class M world is the fifth of ten orbiting a moderate yellow star (UFC 24187) with class 1 facilities. It is presently being developed by both the Federation and the Klingon Empire as an agricultural colony. The Federation colony on the

southern continent has had some success with the grain quadrotriticale as a staple crop. Total pop: 42,000

SIGMA DRACONIS (23.4, 60.4, 5.4)

A moderate yellow G-9 star orbited by nine planets, three of which (planets III, IV and VI) are Class M and inhabited by intelligent life. The third planet is pre-industrial, with a population of 2.1 billion and a rating of B on the Richter Scale. The fourth planet has a Richter rating of G, and has developed rudimentary interplanetary flight (pop: 6 billion). Planet VI is entirely glaciated, but supported an advanced technological civilization before the current ice age. Artifacts of this culture are still evident in underground caverns (pop: 179,000).

SIGMA IOTIA (−5.7, −144.2, −109.1)

First contacted c. 2167 by the U. S. S. *Horizon*, Iotia is the second planet of nine orbiting a large yellow star (class 0 facilities). An intelligent society on the verge of industrialization was contaminated by the *Horizon*, and is now a Federation Protectorate with a cultural rating of E+ on the Richter Scale.

61 CYGNI — *see: TELLAR*

SOL (23.9, 61.8, 0.0)

A moderate size yellow star orbited by ten planets (class 4 facilities). The third planet, Terra or Earth, is extensively populated, and is the home world of the human species. One of the founding worlds of the UFP, Terra is a major cultural and scientific center, and one of the most technologically advanced planets in the Federation. Star Fleet, a successor to the Terran UESPA, is based in the port city of San Francisco. Terra's only natural satellite, Luna, is also extensively populated, and the underground city of Lunaport is the fifth largest in the Federation. Sol IV, or Mars, is a class K planet in the process of being terraformed for surface habitation, and a number of colonies with a total population of 580 million have been independent from Terran authority since the early 21st century. Extensive mining colonies are also located on Mercury (Sol I), Ceres, and Ganymede. Total system population: 31 billion

STAR CLUSTER NGC 321 — *see: EMINIAR*
STAR SYSTEM 611 — *see: UFC 611 Beta*

TALOS (−119.4, −43.7, −24.0)

A binary system in a globular cluster (class 0 facilities), Talos is a red giant orbited by eleven planets. The fourth planet is Class M, and was once the site of an advanced spacefaring culture.

Prohibited P-007

No vessel, under any condition, emergency or otherwise, is to visit Talos IV. To do so is punishable by death.

TANTALUS (−89.7, −11.7, −3.3)

A white dwarf orbited by six planets, of which the fifth planet is marginally Class M. Tantalus V is the site of the Tantalus Penal Colony, a rehabilitation facility for the criminally insane (class 1 facilities). Population of staff and inmates: 147

Prohibited P-179

Tantalus is a restricted area. Only authorized spacecraft are permitted in this system.

TARSUS (−76.5, 138.5, −27.0)

A moderate size red-orange star with five planets (class 1 facilities), one of which, Tarsus IV, is Class M. A Federation colony of 8,050 was established on this planet about 2213, and was the site of a mass execution when Kodos, the Deputy Commander, ordered the deaths of half the population to conserve a dwindling food supply. Pop: 4330

TAU CETI — *see: KAFERIA*
TAURUS — *see: EL NATH*

TELLAR [61 Cygni] (25.0, 60.1, 2.6)

Tellar is the fifth world of eight orbiting 61 Cygni A, an orange dwarf in a binary system (class 3 facilities). The home of an intelligent porcine species, Tellar is one of the founding worlds of the Federation and was one of the first inhabited planets discovered by Earth (Sol III) explorers. Tellarites, although belligerent by nature, have an advanced technology and are superb engineers. Pop: 11.8 billion

TELLUN (−209.9, −38.9, −9.6)

A binary system composed of a yellow giant and a blue dwarf (class 2 facilities). Tellun supports seven planets, including two Class M worlds. The first planet, Troyius, and the second planet, Elas, have evolved independent humanoid cultures, and have been in a state of mutual warfare since interplanetary travel was discovered on Troyius. A truce was recently reached with the marriage of the Dohlman of Elas to the Troyian Prefect.

THASUS (45.8, 59.0, −12.6)

The third planet circling a small red dwarf (class 0 facilities), Thasus is a barren Class L world unsuitable for human life. Once thought to be uninhabited, recent findings show that a race of non-corporeal beings have evolved on this planet from conventional humanoid ancestors.

THETA (−151.3, −86.4, −3.7)

A blue giant in a binary system, Theta has eleven planets, the seventh of which is Class M (class 1 facilities). The Theta VII colony, established about 2147, is located underground to shield it against the seasonal flares of the system's primary. The chief industries include mining and subterranean farming. Pop: 14,500

THETA CYGNI (61.8, 27.7, 23.2)

A moderate size white star with thirteen planets (class 0 facilities), Theta Cygni once supported an advanced spacefaring civilization on its twelfth planet. This civilization was destroyed by the flying parasites several decades before the planet's discovery in the 2180's, and few relics remain of the planet's native culture.

TIBURON [Omega Fornacis] (−121.9, −207.4, 236.4)

The third planet of seven orbiting Omega Fornacis A, a dim red dwarf in a binary system (class 3 facilities), Tiburon is the home world of an advanced humanoid race that is one of the most distant members of the Federation. Although the natives exhibit several physiological differences from the pan-humanoid norm, they are essentially human. It has even been suggested that they are a mutated form of *homo sapiens*, as Tiburon was also the name of a 20th century suburb of the Terran city of San Francisco. Pop: 891 million

TIME PLANET (−10.4, −51.8, −212.9)

The only planet of a dying red dwarf star (class 0

facilities), the Time Planet was the home millions of years ago of a race of immensely advanced beings, the so-called Guardians of Forever. This civilization is now extinct, but one of their artifacts, a sentient time portal, is still operational.

Prohibited P-119

No vessel, under any condition, emergency or otherwise, is to visit the Time Planet.

TRIACUS — *see: ANDOR*
TRISKELION — *see: M 24—ALPHA*

TYCHO (61.8, 216.1, −13.4)
A white dwarf in a gobular cluster (class 0 facilities), Tycho supports four planets, including one marginally Class M world (planet IV). The atmosphere of this planet was recently ripped away by an anti-matter explosion.

TYPERIAS [Lambda Persei] (−286.2, −62.1, 171.6)
This is the second of three planets orbiting UFC 6554309, a moderate size red-orange star (class 0 facilities). The planet is not Class M. However, some of the native minerals have useful medical properties.

UFC 113 (−23.6, −81.9, 0.7)
A system of seven planets orbiting a yellow dwarf star (class 0 facilities), one of which (planet IV) is Class M. At one time, M 113 supported an advanced non-humanoid civilization that died out when the planet's supply of natural sodium chloride was exhausted (salt was an essential additive to the natives' biochemistry). A survey led by archaeologist Robert Crater discovered one surviving member of this ancient civilization, indicating extreme longevity, perhaps in a state of hibernation or suspended animation.

UFC 611 (90.1, 71.9 −2.4)
A bright yellow star in a binary system (class 0 facilities), UFC 611—Beta has a system of five planets, the third of which is Class M. Although once an advanced civilization, the inhabitants of Beta III are an arrested culture, controlled until recently by a powerful computer. Pop: 375,000

UFC 892 (−132.1, −101.1, −56.7)
A yellow dwarf (class 0 facilities), UFC 892 has a system of eleven planets that closely parallels Sol's planetary system, although an additional planet exists in a close orbit around the system's primary. Planet 892-IV is inhabited by a humanoid race rating E+ on the Richter Scale, roughly approximating Terran culture in the mid-20th century. Pop: 4.3 billion.

Prohibited P-892

This system is protected under the Prime Directive of Non-Interference, and any unauthorized contact with its natives is expressly forbidden.

UFC 347601 (−43.3, −103.5, −82.3)
A yellow dwarf orbited by ten planets (class 0 facilities), UFC 347601 is identical to the Sol system in all measurable parameters. The third planet, called Miri's World (an obscure derivation), is a Class M world exactly the same size and mass as Terra, and the configuration of the continents is identical. A race of adolescent humans, the Onlies, occupies the planet under the guidance of a Federation sociological team. Pop: 13 million

URSULA [beta Vela] (−68.4, 215.3, −335.6)
The outermost planet of four orbiting b Vela, a white giant (class 0 facilities), Ursula is a Class N world with only one habitable land mass. Although native life is primitive, several species of Ursulian flora have medicinal uses.

VEGA [Alpha Lyrae] (28.2, 61.3, 6.9)
A large white star with ten planets (class 1 facilities), the ninth of which is Class M and is inhabited by both an advanced humanoid race and a small human settlement. Neither group is native, although the humanoids (a colony of the planet Delta III) predate the Federation settlement by almost a century. The race native to Vega IX is now believed to be extinct, but once controlled a large volume of space as what is now called the Vegan Tyranny. The nature of the native Vegans is unknown, and it has been speculated that they were inorganic, or even cybernetic, in composition. Pop: 280 million

VENDIKAR — *see: EMINIAR*
VULCAN — *see: 40 ERIDANI*

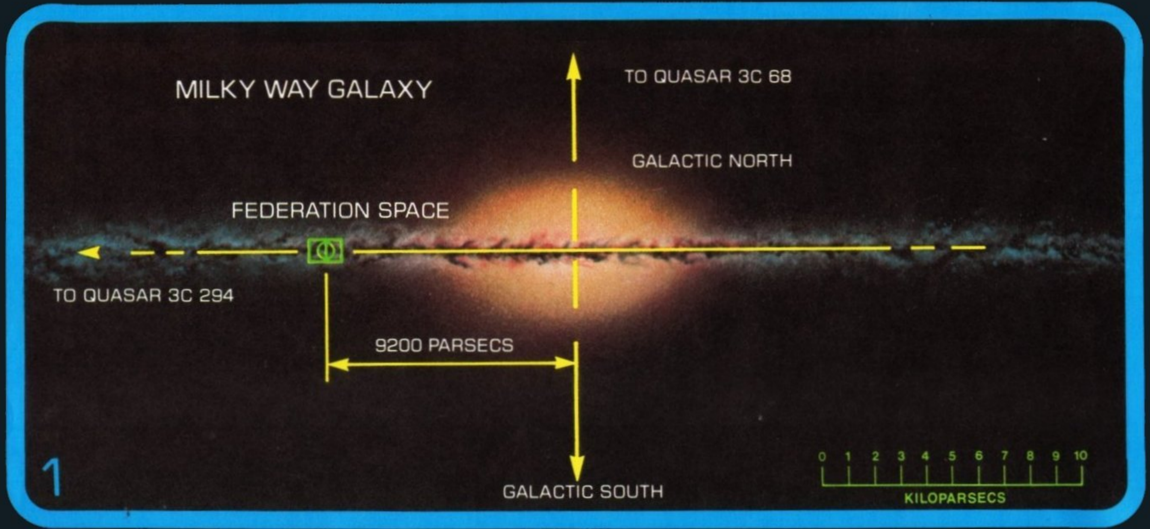
WRIGLEY'S PLEASURE PLANET (−20.0, −48.1, 0.8)
Founded in 2238 by an interplanetary entertainment cartel, Wrigley's Pleasure Planet is a rogue planetoid about 600 km in diameter. Large areas of the planet's interior have been converted into entertainment complexes, including theme parks simulating the environments of major planets in the Federation (class 3 facilities).

YONADA (?,?,?,)
A hollow asteroid about 100 km in diameter, Yonada was adapted by the ancient Fabrini for use as a multigenerational, slower-than-light starship to carry a small percentage of the system's population to a new home. Yonada is now in orbit around new Fabrina, the third planet of UFC 376082 (class 1 facilities).

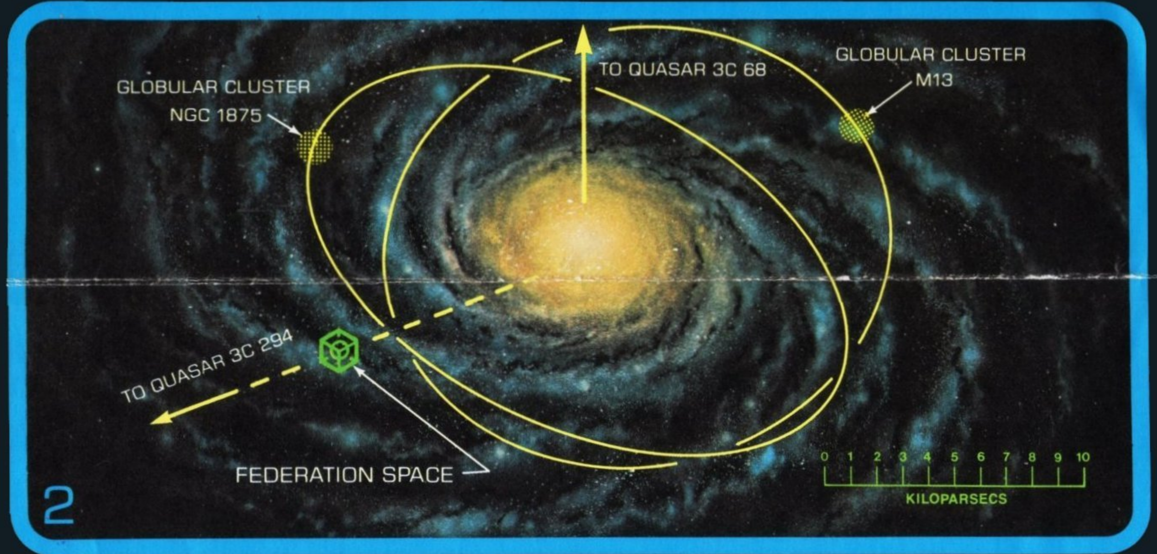
ZETA BOOTIS — *see: NEURAL*

ZETAR (−92.6, −116.2, −23.8)
The second planet of three orbiting a small red dwarf, all life on Zetar was destroyed when the star expanded into a red giant several millenia ago.

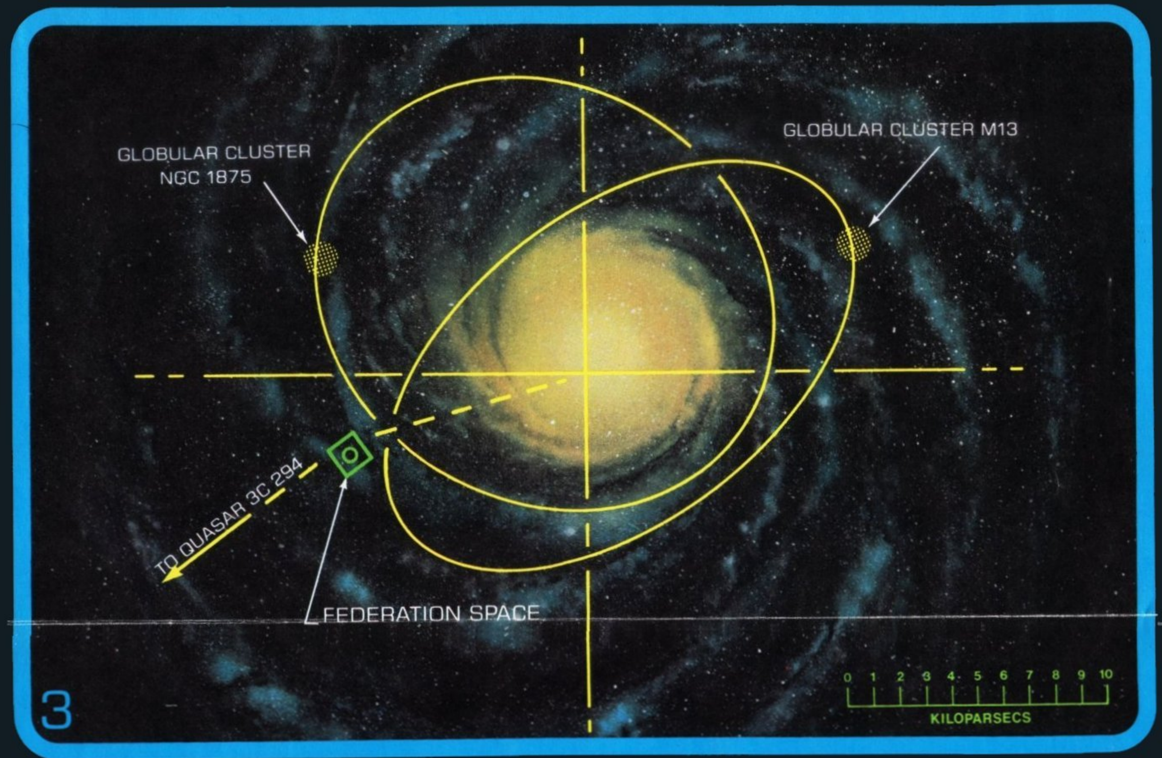
UNITED FEDERATION OF PLANETS



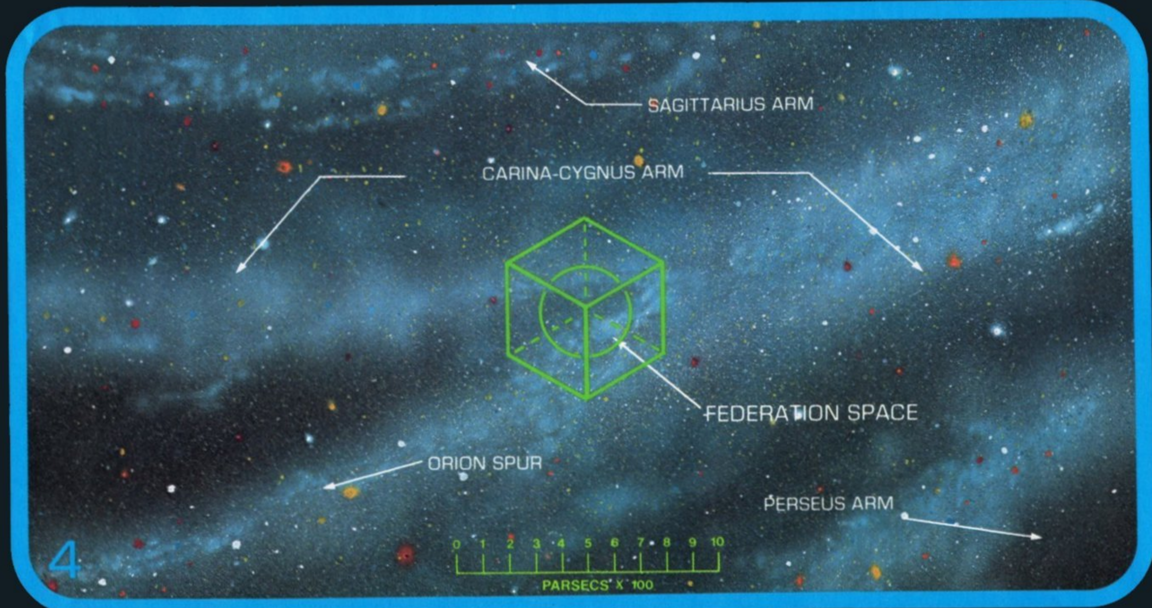
1



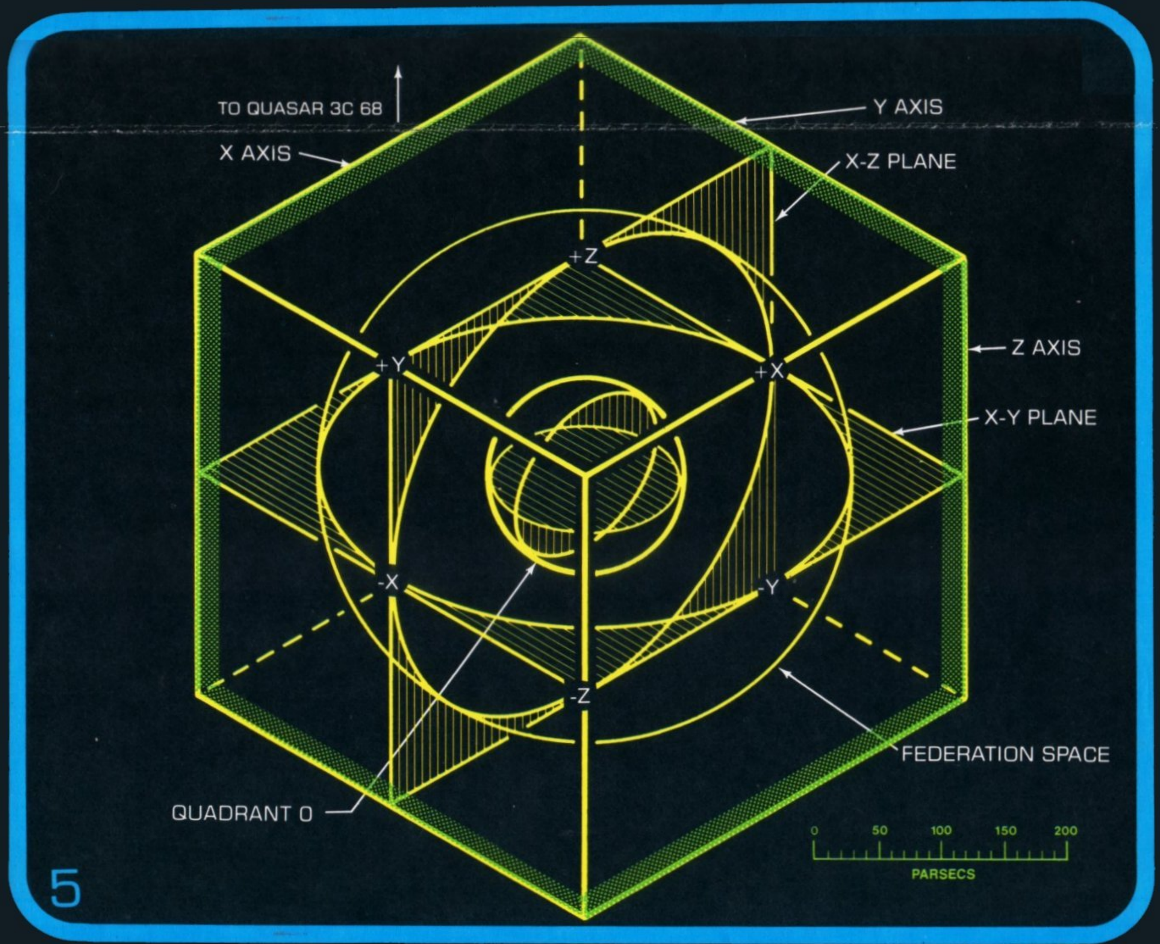
2



3



4



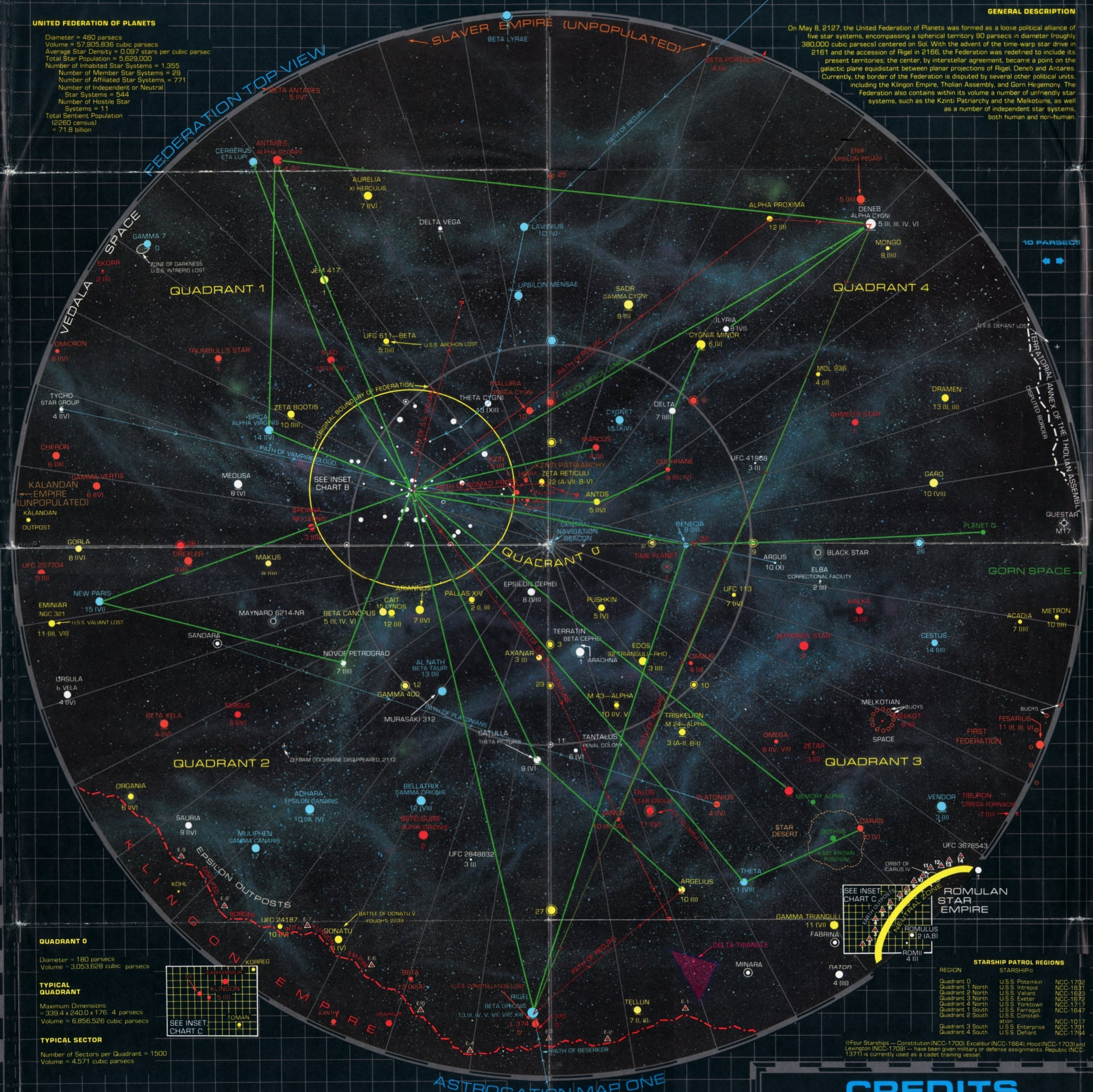
5

UNITED FEDERATION OF PLANETS

Diameter = 480 parsecs
Volume = 57,905,836 cubic parsecs
Average Star Density = 0.097 stars per cubic parsec
Total Star Population = 5,629,000
Number of Inhabited Star Systems = 1,355
Number of Member Star Systems = 29
Number of Affiliated Star Systems = 771
Number of Independent or Neutral Star Systems = 544
Number of Hostile Star Systems = 11
Total Sentient Population (2260 census) = 71.8 billion

GENERAL DESCRIPTION

On May 8, 2127, the United Federation of Planets was formed as a loose political alliance of five star systems, encompassing a spherical territory 90 parsecs in diameter (roughly 380,000 cubic parsecs) centered on Sol. With the advent of the time-warp star drive in 2161 and the accession of Rigel in 2166, the Federation was redefined to include its present territories; the center, by interstellar agreement, became a point on the galactic plane equidistant between planar projections of Rigel, Deneb and Antares. Currently, the border of the Federation is disputed by several other political units, including the Klingon Empire, Tholian Assembly, and Gorn Hegemony. The Federation also contains within its volume a number of unfriendly star systems, such as the Kzinti Patriarchy and the Melkotians, as well as a number of independent star systems, both human and non-human.



QUADRANT 0

Diameter = 180 parsecs
Volume = 3,053,628 cubic parsecs

TYPICAL QUADRANT

Maximum Dimensions = 339.4 x 240.0 x 176. 4 parsecs
Volume = 6,856,526 cubic parsecs

TYPICAL SECTOR

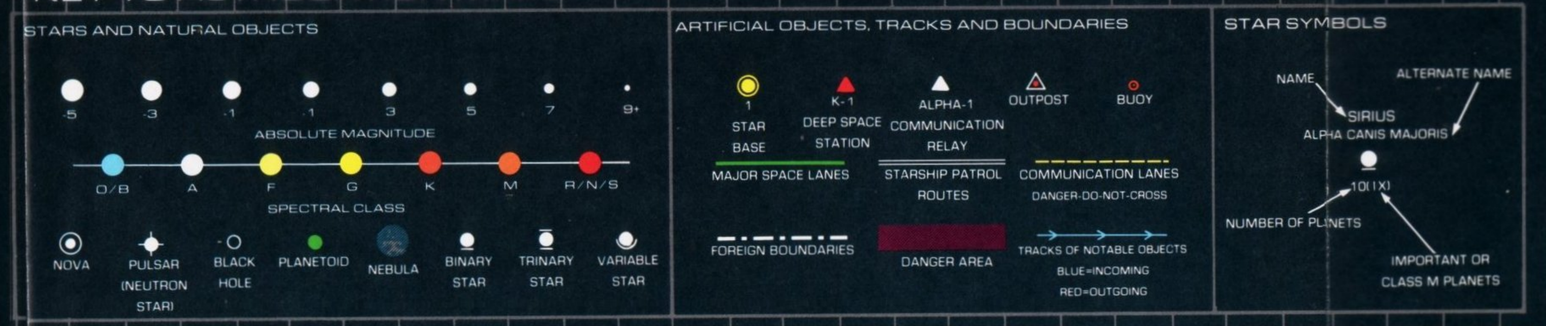
Number of Sectors per Quadrant = 1500
Volume = 4,571 cubic parsecs

STARSHIP PATROL REGIONS

REGION	STARSHIP※	
Quadrant 0	U.S.S. Potemkin	NCC-1702
Quadrant 1 North	U.S.S. Intrepid	NCC-1631
Quadrant 2 North	U.S.S. Valiant	NCC-1623
Quadrant 3 North	U.S.S. Exeter	NCC-1672
Quadrant 4 North	U.S.S. Yorktown	NCC-1717
Quadrant 1 South	U.S.S. Farragut	NCC-1647
Quadrant 2 South	U.S.S. Constell-ation	NCC-1017
Quadrant 3 South	U.S.S. Enterprise	NCC-1701
Quadrant 4 South	U.S.S. Defiant	NCC-1764

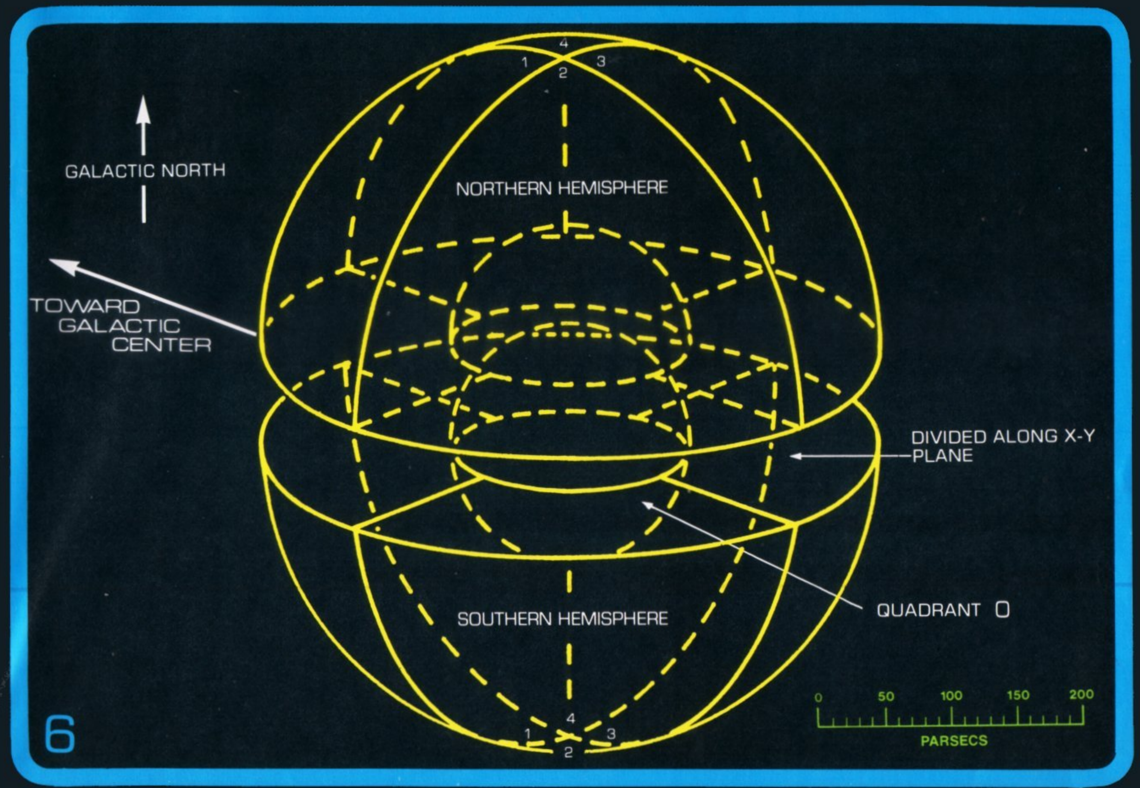
※Four Starships — Constitution (NCC-1700), Excalibur (NCC-1664), Hood (NCC-1703) and Lexington (NCC-1709) — have been given military or defense assignments. Republic (NCC-1371) is currently used as a cadet training vessel.

KEY TO ASTROGATION MAPS

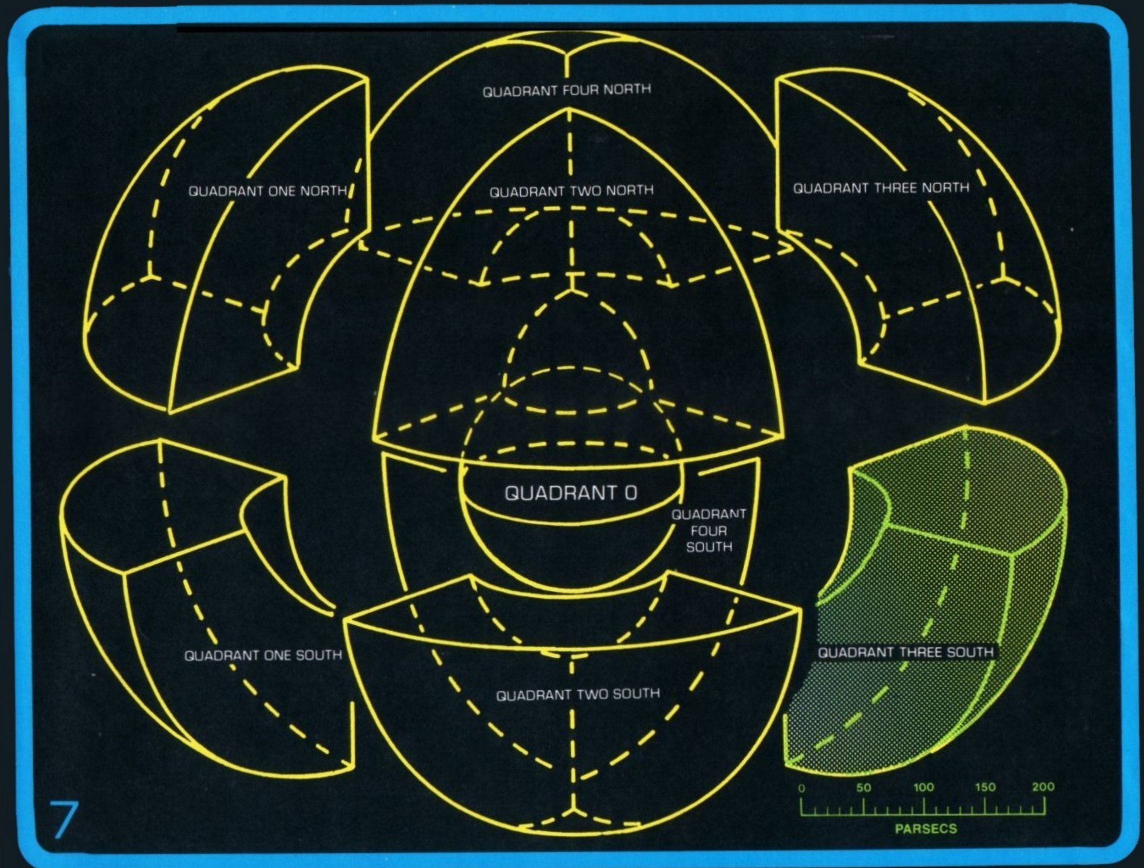


CREDITS

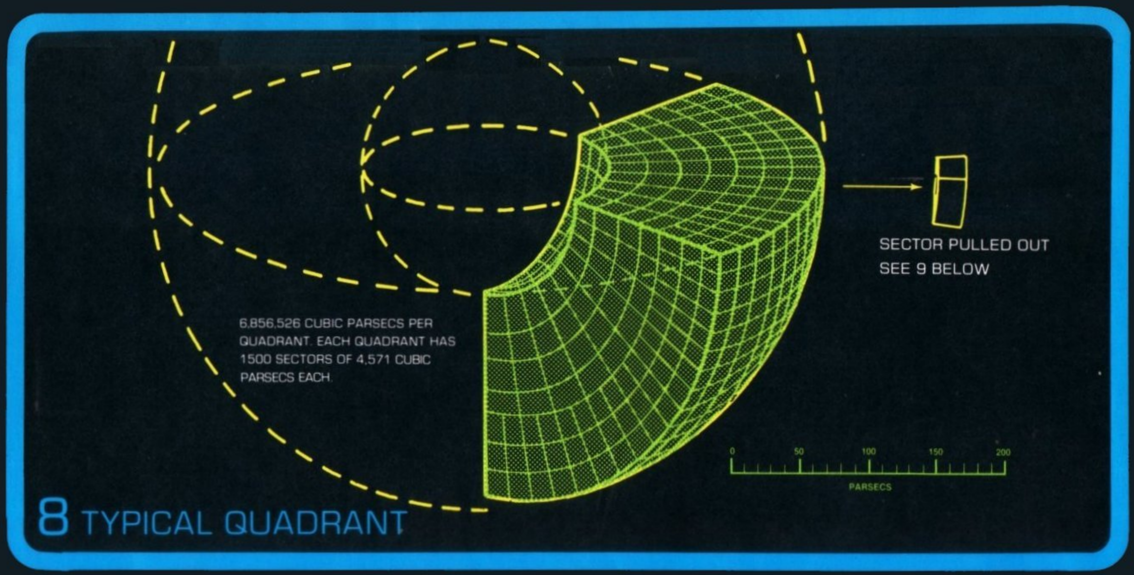
Design & Co-ordination	Jeffrey Maynard
Technical Direction	Michael McMaster
Astronomical Art	Geoffrey Mandel
Technical Graphics	Lee Cole
Air Brush Art	Michael Nicastre
	Rick Sternbach
Mechanical Production	Barbara White
Manual	John Upton
Technical Assistance	Sara Hillman
From an idea Suggested by	Rena Wolner
Editor for Bantam	Sydny Weinberg



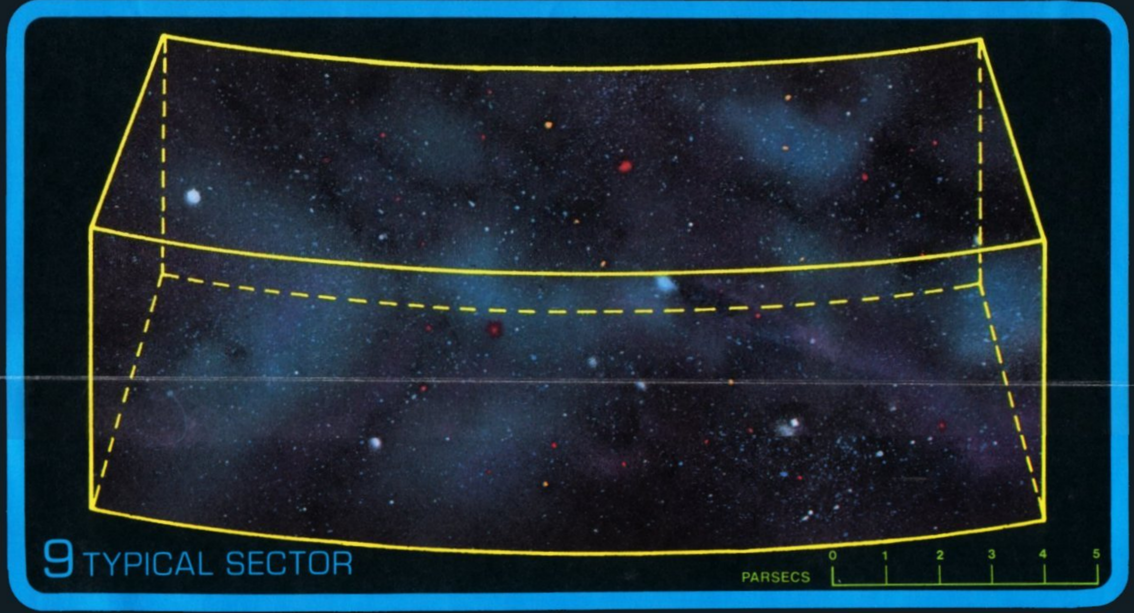
6



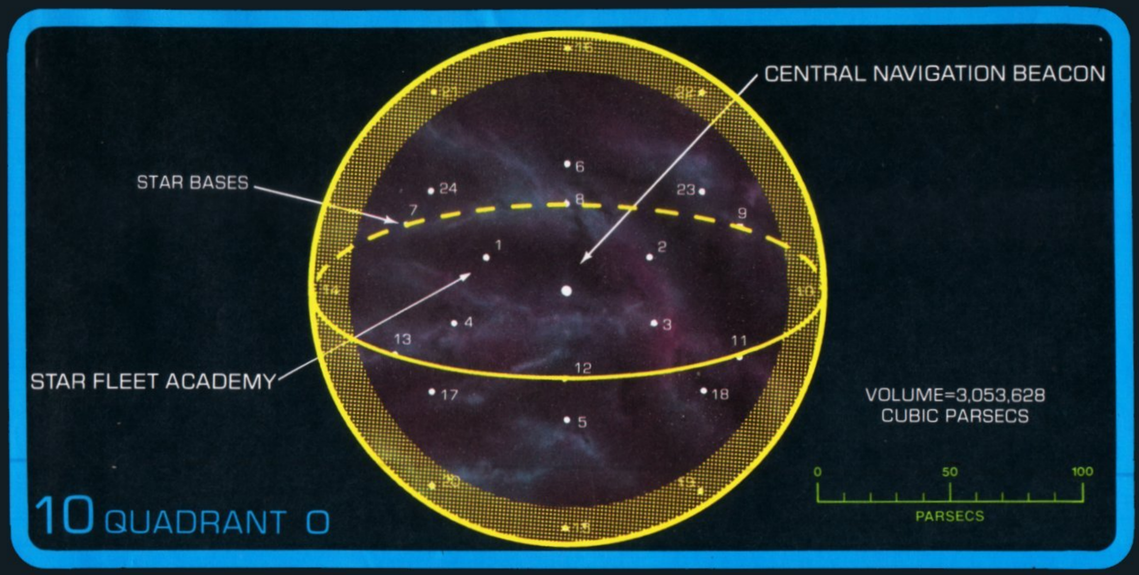
7



8 TYPICAL QUADRANT


9 TYPICAL SECTOR

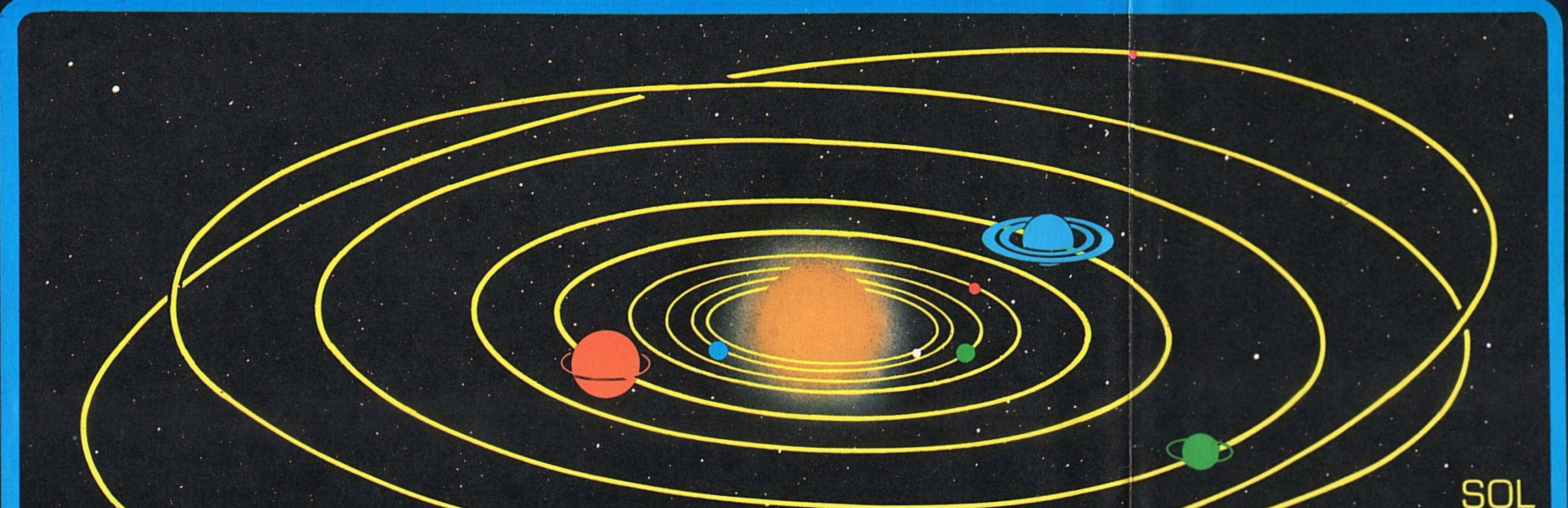


10 QUADRANT 0

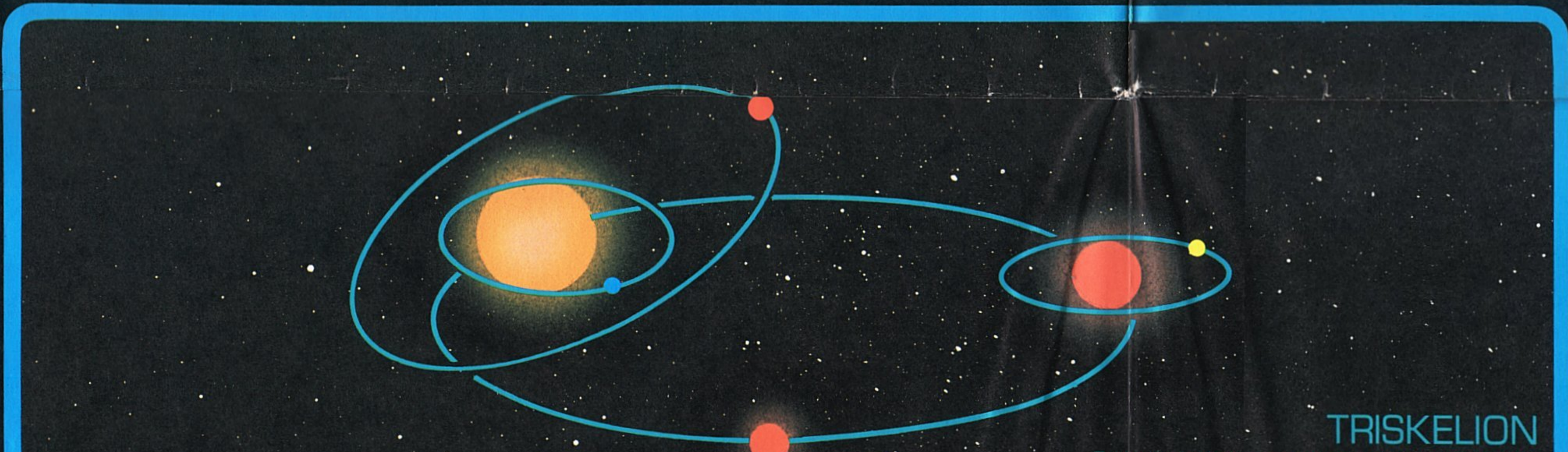
CHART A



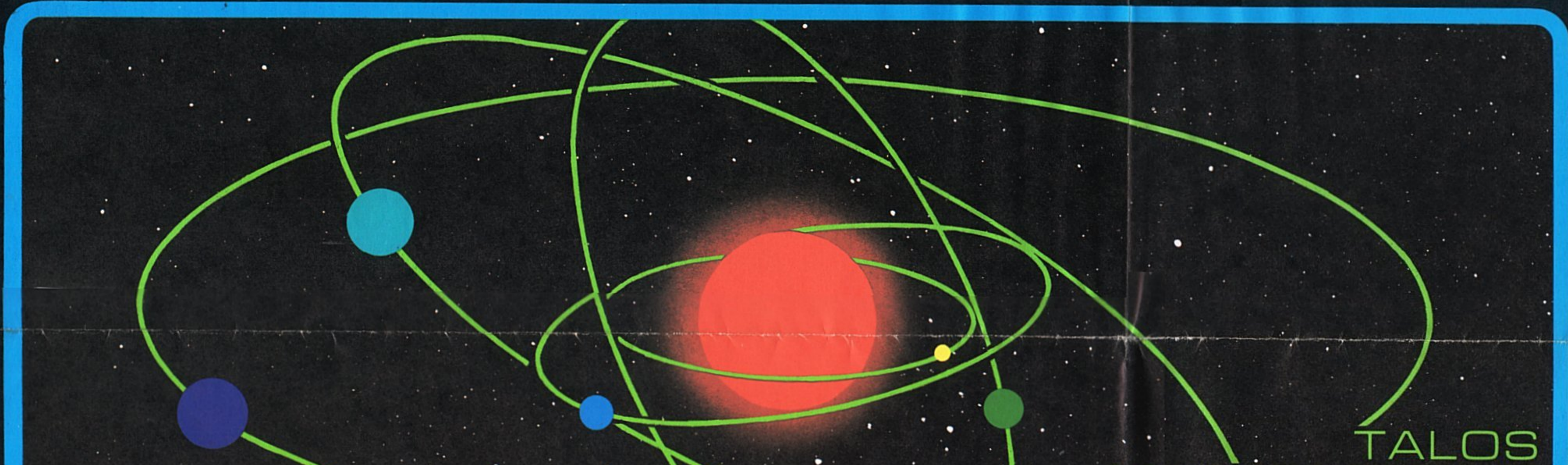
NAMED PLANETS AND THEIR PRIMARIES
SPACE VESSELS — FEDERATION
STARLINER
CONSTITUTION/ CLASS STARSHIP
DY CLASS SLEEPER SHIP
SPACE CRUISER
CLASS F SHUTTLECRAFT
ALIEN VESSELS
FESARIUS
THOLIAN SPACE CRUISER
KLINGON BATTLE CRUISER
ROMULAN "BIRD OF PREY"
NOMAD PROBE/ TAN RU
ASTROGATION MAP THREE TOP VIEW
INSET FROM CHART A
KZINTI PATRIARCHY
10 PARSECS
ORIGINAL BOUNDARY OF FEDERATION X-Y PLANE
FEDERATION SIDE VIEW
ENERGY BARRIER
QUADRANT 3 NORTH
QUADRANT 4 NORTH
QUADRANT 0
QUADRANT 3 SOUTH
QUADRANT 4 SOUTH
AREA OF CONTACT WITH KLINGON EMPIRE
AREA OF CONTACT WITH ROMULAN STAR EMPIRE
AREA OF CONTACT WITH THOLIAN ASSEMBLY
DELTA TRIANGLE
TOWARD GALACTIC CENTER
GALACTIC NORTH BEACON
GALACTIC SOUTH BEACON
MEMBER SYSTEMS OF THE UNITED FEDERATION OF PLANETS
Listed in Order of Admittance
STAR SYSTEM
YEAR
ORIGINAL BOUNDARY OF FEDERATION X-Z PLANE
ASTROGATION MAP FOUR SIDE VIEW
INSET FROM CHART B
ASTROGATION MAP TWO X-Z PLANE
SHIP'S RECORDER-MARKER
APPROACH POSITION BEACON
BUOYS AND OTHER OBJECTS
DEEP SPACE STATION
REGIONAL MARKER BUOY
FIRST FEDERATION BUOY
KZNTI MARKER BUOY
MELKOTIAN BUOY
KLINGON MARKER BUOY
NAVIGATION BEACONS
PLANETARY CLASSIFICATION
KEY TO ASTROGATION MAPS
STARS AND NATURAL OBJECTS
ARTIFICIAL OBJECTS, TRACKS AND BOUNDARIES
STAR SYMBOLS
CHART B
Copyright 1980 by Paramount Pictures Corporation. All Rights Reserved.



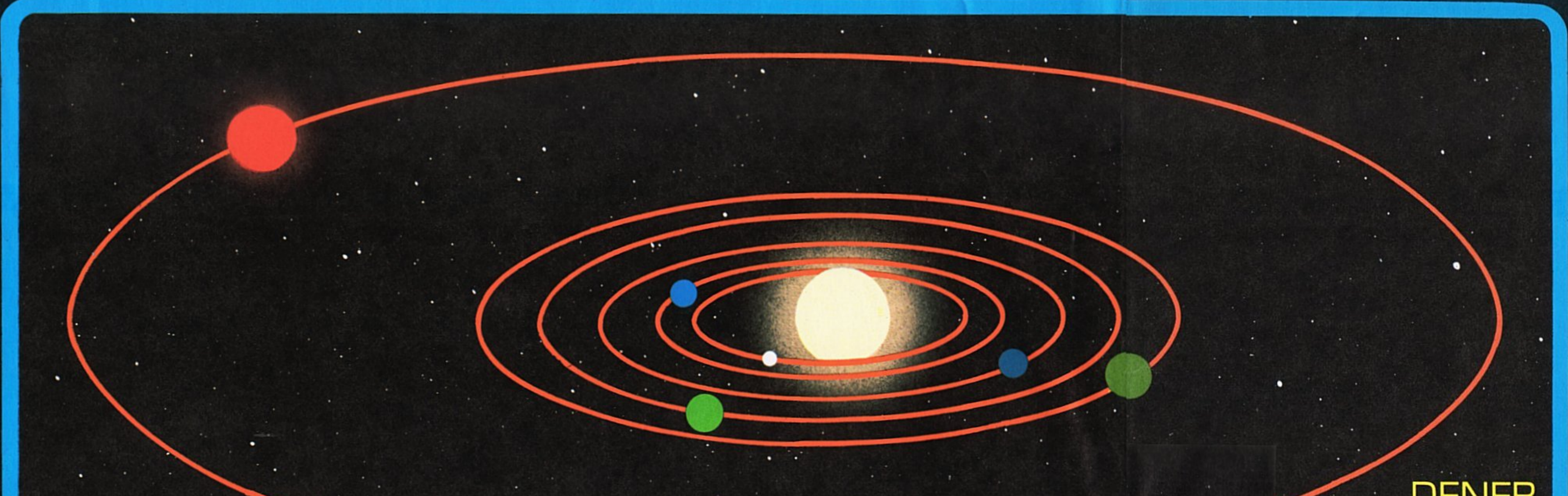
The Sol system, with two Class M planets (Terra and Mars), is considered a typical stellar system: the four inner planets are of terrestrial composition, and five of the six outer planets are gas giants (Persephone, the tenth planet, orbits at 79 AU, and is not illustrated here). The outermost terrestrial planet, Pluto, is believed to be an escaped moon of the gas giant Neptune, explaining its eccentric elliptical orbit.



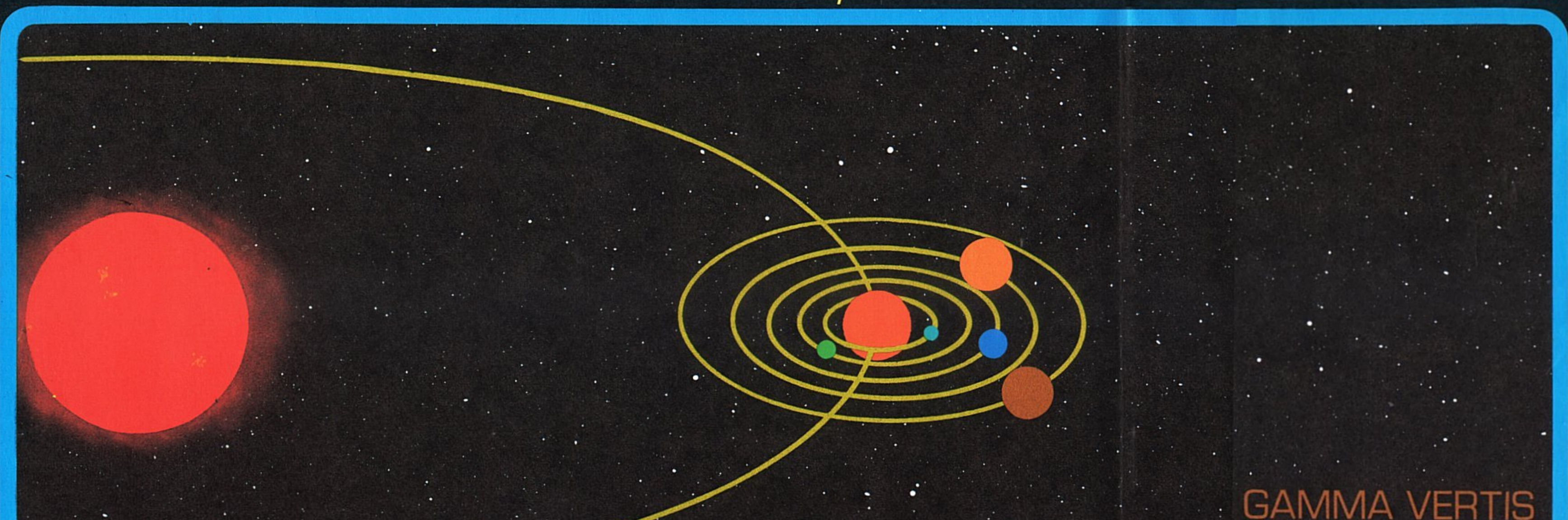
Triskelion is the second planet orbiting the star M 24—Alpha, the primary in a trinary star system. The M 24 system is unusual in that the three stars have evolved a stable trojan relationship, all orbiting around a single center of gravity, and hence can support planetary systems. In addition to the two planets orbiting the primary, a single Class M planet orbits the system's secondary star.



The Talos star group is composed largely of white dwarves and other "stellar corpses," but one red giant still support a planetary system. The five inner planets are remarkable for their highly eccentric orbits, believed to be the result of terraforming or planetary engineering; six other planets, all gas giants (not illustrated here), have more conventional orbits and have become tidally locked with the same face always toward the primary.



The Denebian system supports four Class M worlds (II through V) out of a total of five; outer planets, if any; have probably been displaced by a dim red dwarf star that orbits the primary at a distance of about 42 AU. The red dwarf is believed to be a fairly recent acquisition of the primary star.



The only Class M world in this system is actually the fourth of a total of five orbiting a large gas giant; this giant, a "failed star" of about 3.5 Jupiter masses, radiates a considerable amount of energy, and the system should perhaps be thought of as a binary one.

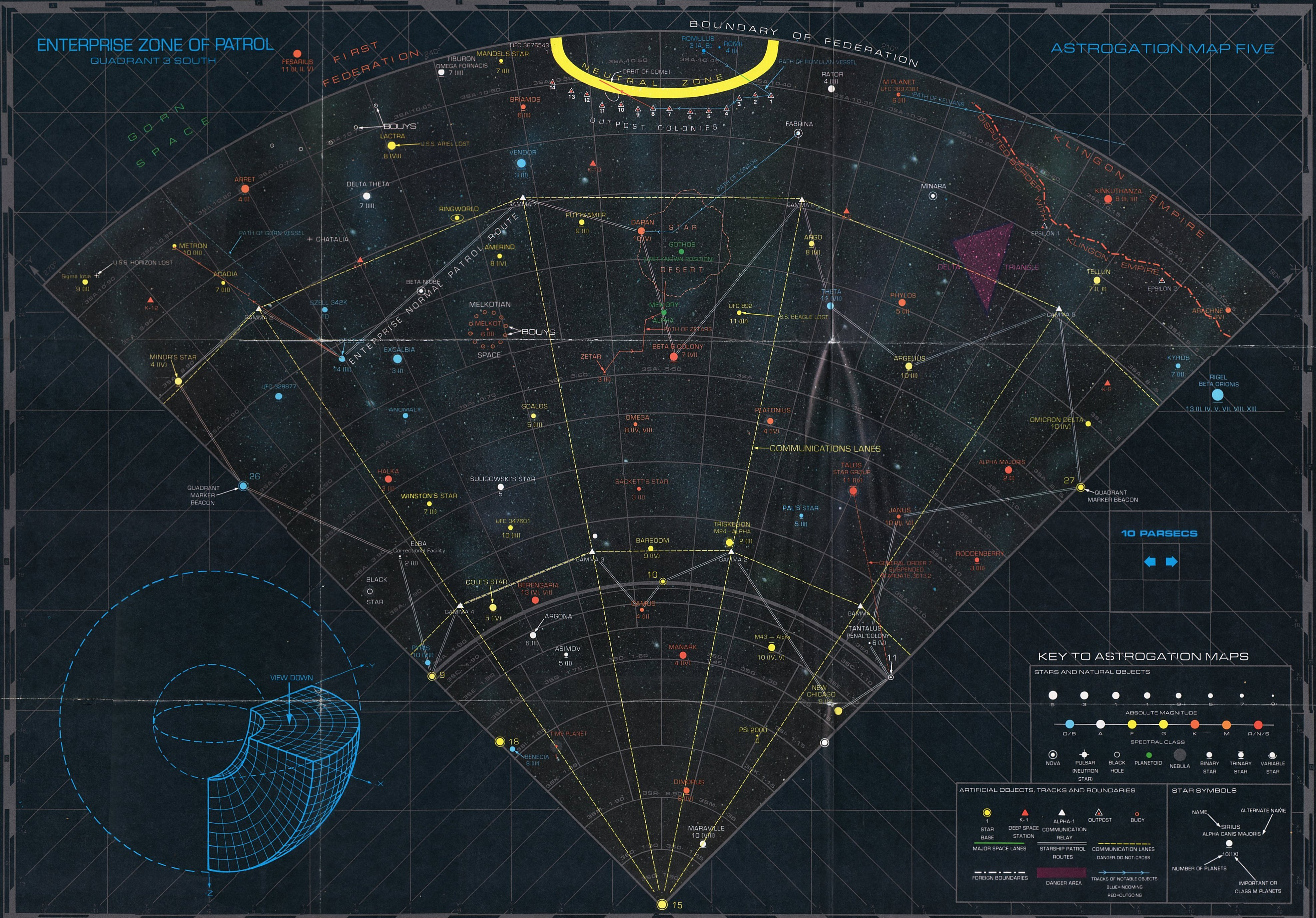




CHART C

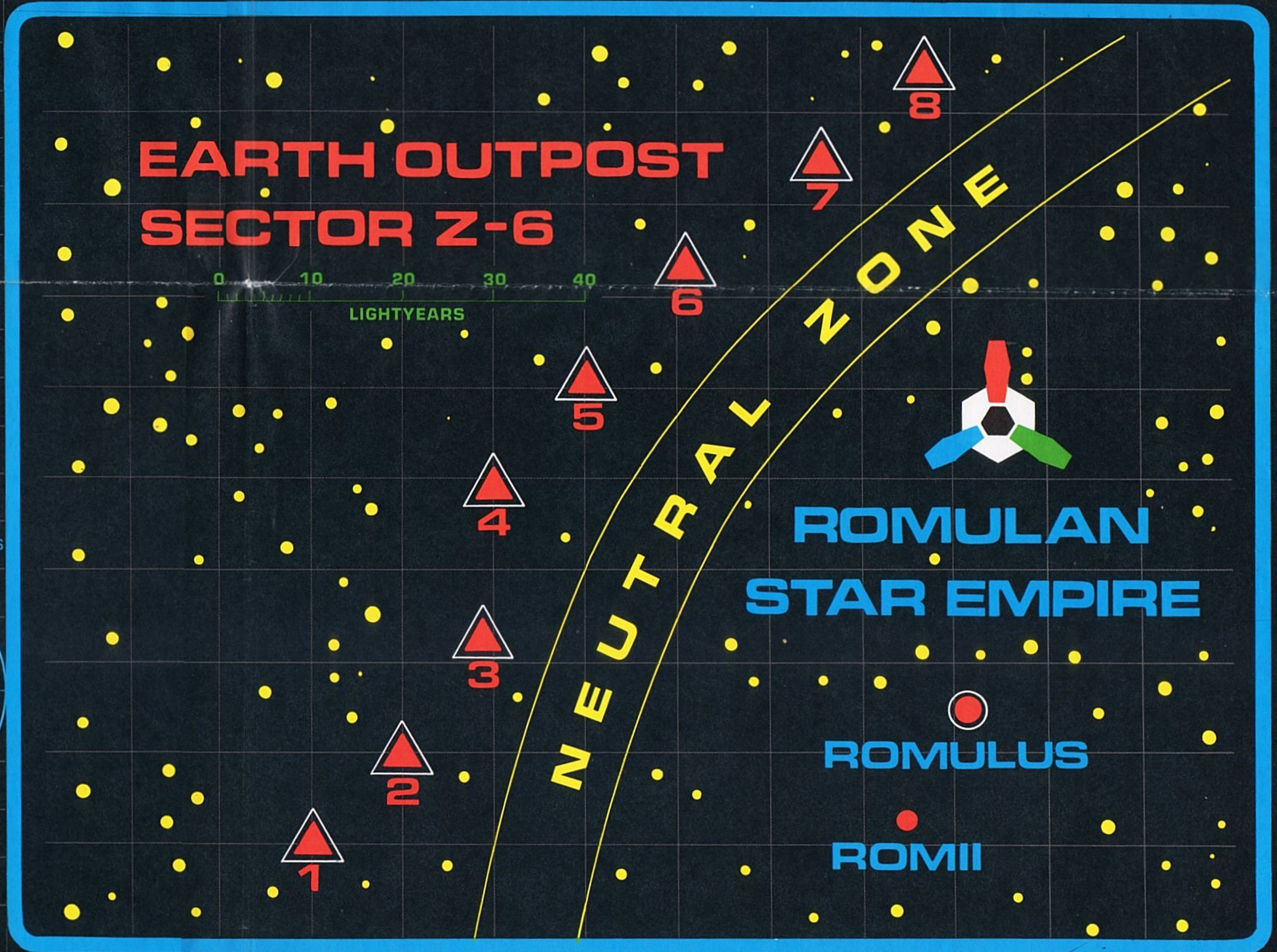
KLINGON EMPIRE

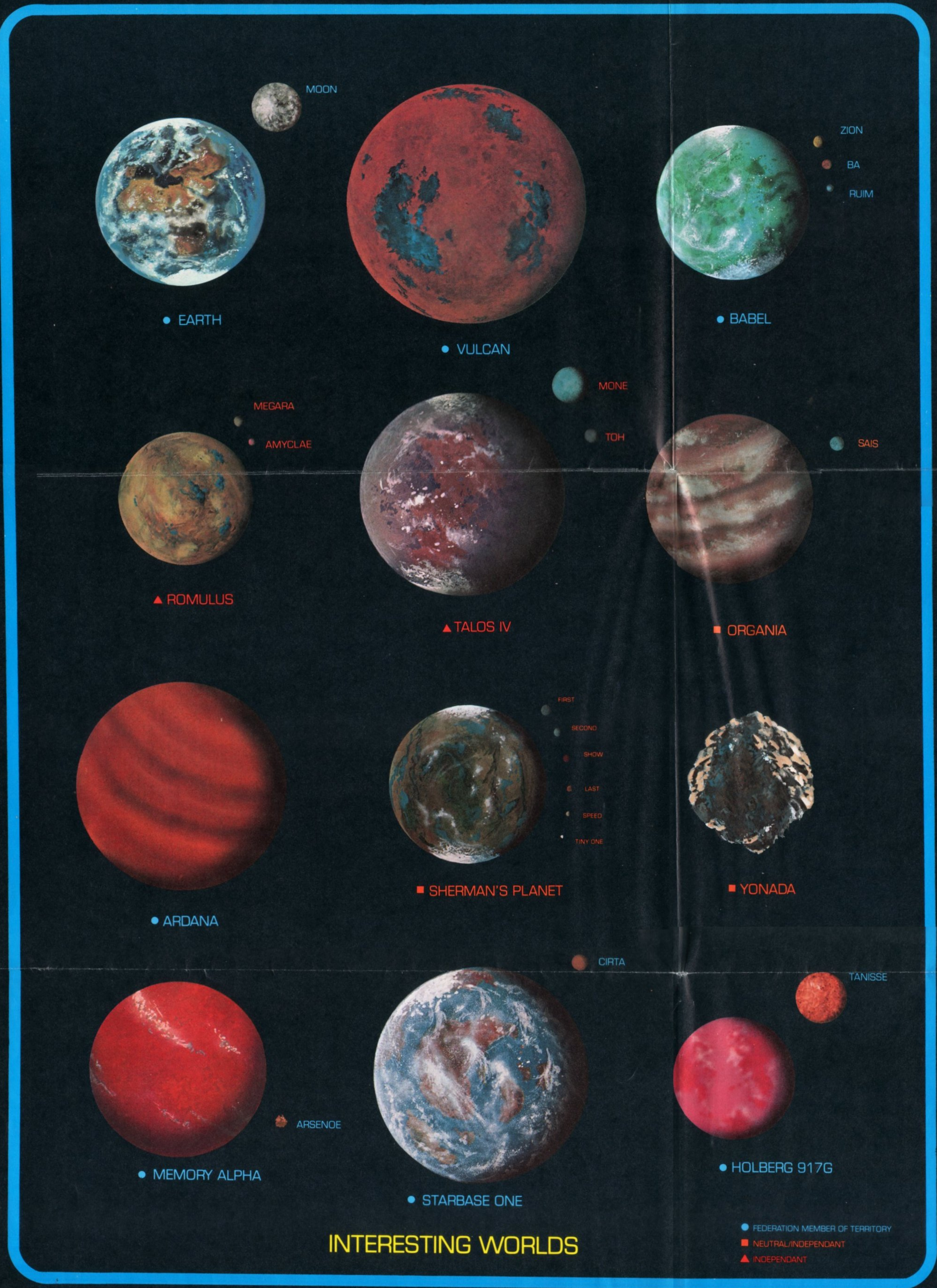
The inner star systems of the Klingon Empire are illustrated here, to the extent of Federation intelligence data. The Klingon home planet, Kazh, the second planet of an orange binary star, is protected by a ring of eight heavily-armed battle stations at a distance of about 40 light-years. These stations also serve as bases for the warships that patrol Klingon space.

ROMULAN STAR EMPIRE

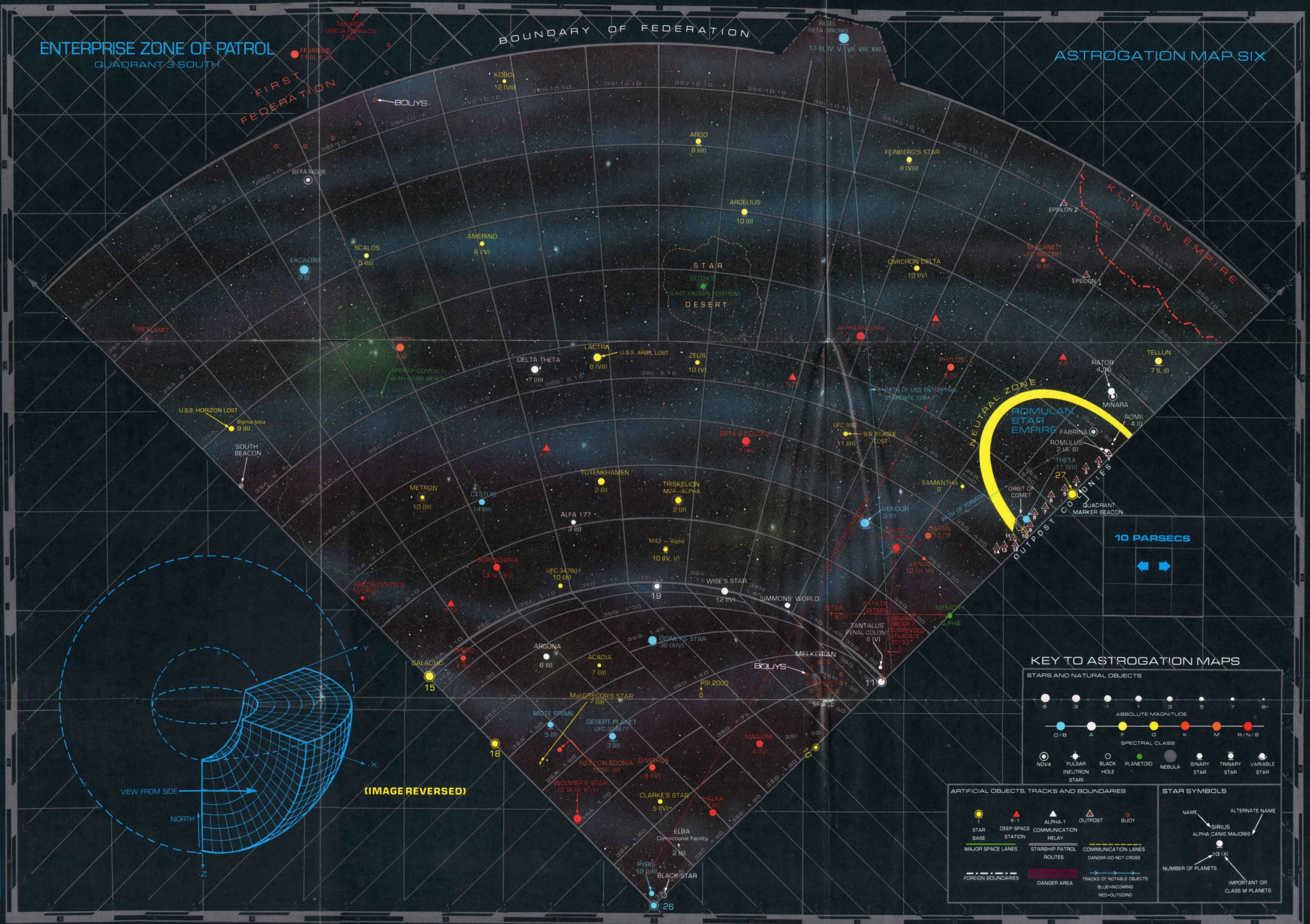
This view shows the Romulan Neutral Zone, ten light-years in width and extending a maximum of 50 light-years into Federation space. This zone, negotiated over subspace radio in 2162, is protected on the Federation side by a series of asteroid outposts that monitor traffic on both sides. Entry into the zone by either side constitutes an act of war under the terms of interstellar treaty.







INTERESTING WORLDS




CHART D

STAR TREK® MAPS

FOUR DELUXE WALL MAPS SUITABLE FOR FRAMING IN STELLAR FOUR COLOR· PINPOINTING ALL THE FEDERATION PLANETS· NEUTRAL ZONES AND BEYOND. PLUS: OFFICIAL 32 PAGE TECHNICAL MANUAL

